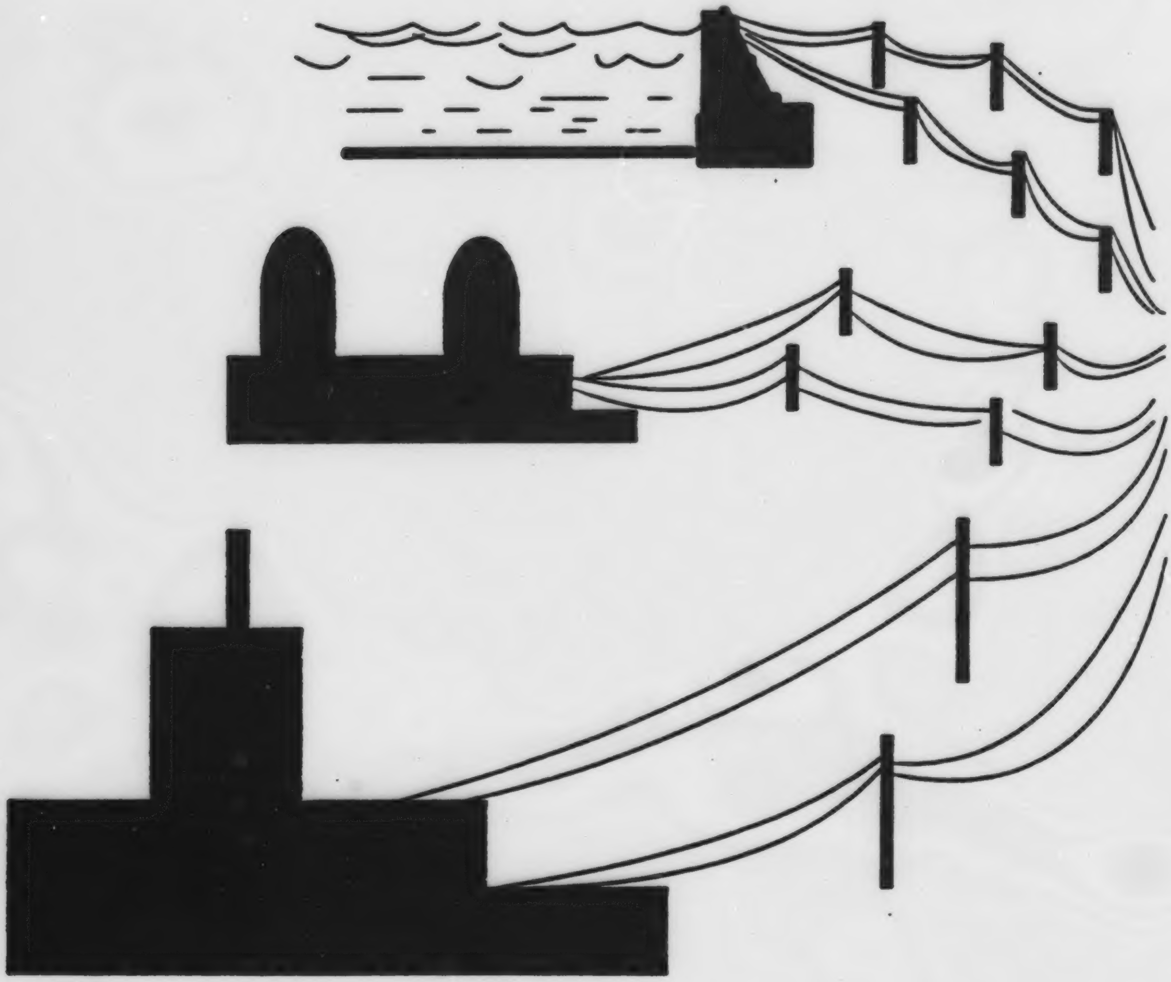
INTER-UTILITY TRADE REVIEW

TRANSMISSION ACCESS AND WHEELING



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INTER-UTILITY TRADE REVIEW

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KEY FINDINGS AND OPTIONS

The following paragraphs summarize the key findings stemming from the Board's assessment of possible measures to enable potential buyers and sellers of electricity to obtain commercial access to available transmission capacity through intervening provinces for wheeling purposes. The assessment was carried out at the request of the Minister of Energy, Mines and Resources, and forms part of the Board's overall review of Inter-utility Cooperation which is described in a separate volume. This summary also includes a range of possible options that appear to be available to encourage and secure greater transmission access and wheeling services.

Transmission access refers to the right or opportunity of electricity generating entities to use transmission facilities owned by others. Wheeling is the authorized use of the transmission facilities of an intermediate entity by two other entities whose transmission facilities are not directly interconnected, in order to sell, purchase or exchange electricity between them. Transmission access and wheeling services have no intrinsic value. However, they can be essential elements in permitting the use of least-cost generating resources over wider geographic areas.

Any transmission access and wheeling policies that are developed should be designed to achieve greater economic efficiency in the supply of electricity, as well as equity in the sharing of the resulting net benefits. Engaging in transmission access and wheeling activities must permit the realization of positive net benefits through the transfer and use of least-cost generation, and not simply result in a reallocation of costs and benefits among the participating entities. Moreover, each participant in these activities must benefit from each transaction after all his related costs are covered. The technical problems associated with transmission access and wheeling are rarely insurmountable but the costs attributable to overcoming these problems must be recognized and should be included in the overall cost of the service.

The wheeling of electricity across transmission grids falls into three basic categories which are referred to here as "system wheeling", "supply wheeling" and "retail wheeling".

Retail wheeling services would be necessary when a generator wished to supply a particular customer not located in the generator's franchise area, and to which it was not directly interconnected. In general, Canadian utilities have mandates from their respective provinces to supply loads within their franchise areas. The direct sale of power from generators to customers would require a radical restructuring of the electricity supply industry, particularly in re-defining the mandates of the utilities. This is a provincial matter and would not involve the federal government directly. Also, it would not involve inter-utility cooperation and, as such, is not within the scope of this assessment. Therefore, retail wheeling was not considered in the current study.

The following paragraphs describe system wheeling and supply wheeling, and provide examples of the types of transactions that can depend on them.

(i) System Wheeling

It is quite normal for a utility to find itself in a surplus condition and, hence, is able to sell power to a second utility that is either in deficit or whose marginal cost of supply is greater than that of the first. When the two utilities are not directly interconnected, the sale and purchase of the surplus power involves wheeling through an intermediate utility's transmission network. This type of wheeling is categorized here as "system wheeling".

Typically, system wheeling is carried out only on a utility-to-utility basis and does not involve non-utility generators. It is used by utilities to extend the geographical area over which they can clear both their short-run and persistent long-run surpluses.

Examples of short-run transactions requiring system wheeling are daily, seasonal and annual sales and exchanges of temporary surpluses of capacity and economy energy; and energy sales from a predominantly hydroelectric utility during years of high water conditions. Short-run system wheeling usually does not depend on the development of new generation or bulk transmission facilities built specifically to support this type of transaction. However, where transmission bottlenecks prevent such activities, some relatively minor strengthening of transmission networks may be necessary.

Examples of requirements for long-run system wheeling are instances where seasonal diversity exchanges between winter and summer peaking systems require transmission service of intermediary parties; where a predominantly thermal utility wishes to sell off-peak surplus energy; and where a predominantly hydro utility has seasonal energy surpluses to sell. Long-run system wheeling does not involve the development of new generation but may necessitate the construction of additional bulk transmission facilities.

As part of this assessment, an estimate was made using the CANEBEX5 model of the short-term benefits that would result from increased economy energy transfers, including bilateral exchanges and wheeling among non-adjacent system, in eastern Canada and the northeastern United States (Ontario, Québec, the Maritimes, New York and New England). The total value of bilateral exchanges available in this region over a five-year period was estimated to be some $3 billion, expressed in 1990 purchasing power. By allowing access to system wheeling services, these benefits were estimated to increase by up to 10 percent. Opportunities for similar short-term energy transfers requiring system wheeling are likely to exist in other regions.

In the parallel study of Inter-utility Cooperation, estimates were made of the additional long-run benefits that would be available from enhanced cooperation. The realization of some of these benefits, including certain seasonal diversity exchanges and/or firm summer sales, would involve system wheeling.

(ii) Supply Wheeling

In the long run, as its native load grows, a utility can be faced with the choice of either building a new generating unit itself, or entering into a contract to purchase equivalent power from another utility or from a non-utility generator. When the cost of the purchase is less than the utility's own long-run marginal cost of supply, it may wish to purchase rather than build. However, when the utility is not directly interconnected to the potential supplier, a long-term arrangement has to be made with an intermediate utility to wheel the power. The transaction may also involve the construction of a bulk transmission line to deliver the power or major additions to existing transmission networks, at least during part of the contract period. Here, this type of wheeling is termed "supply wheeling".

The ability to gain long-term access to wheeling services permits a utility to expand the geographical area from which it can seek new generation sources to meet load growth in its own service area. Competitive bidding for generation can take place on a regional basis. The new generating sources can be owned by either utilities or non-utility generators, including independent power producers.

Estimates were made in the parallel study of Inter-utility Cooperation of the net benefits that might be available from long-term firm sales of electricity. Some of the potential transactions identified would require supply wheeling.

Within the context of the general principles and concepts concerning transmission access and wheeling which are outlined in this assessment; the responses by the provinces, utilities and other interested parties to the transmission policy described in this report; and the broader framework of enhanced inter-utility cooperation which is discussed in a companion report, the following options have been developed with a view to facilitating arrangements to secure transmission access and wheeling services. The options are by no means exhaustive but they provide a reasonable range of alternatives for consideration.

OPTION A - Establish Individual Utility Transmission Access and Wheeling Policies

Although this assessment concludes that there is little commercial wheeling currently taking place in Canada, one utility, B.C. Hydro, has developed transmission access policies and is prepared to enter into wheeling arrangements with other interconnected parties. It is understood that other utilities, notably in Alberta, are also in the process of developing their own transmission access and wheeling policies. Therefore, there appears to be a sense that in the current changing environment, other utilities might also be prepared to address these matters. Under this option, individual utilities would develop their own policies to allow transmission access and wheeling by other utilities and non-utility generators. This option would require no new regulations by the federal government.

OPTION B - Individual Policies with Federal Monitoring

Under this option, the utilities would establish their own policies, and the federal government would undertake to monitor progress on a regular basis. Agreements concluded through voluntary negotiations among utilities or between a utility and non-utility generator could be filed with a federal agency for public information and could be used by other interested parties. Monitoring progress and dissemination of information might provide added impetus for participants to reach agreements through a better understanding of the issues involved and through a sharing of experience gained by parties who have engaged in wheeling and transmission access activities. As in Option A, this option would require no new regulations by the federal government.

OPTION C - Establish an Industry Standard Policy

To be successful, wheeling arrangements require multi-party agreements. This option proposes that within the regional planning entities, as described in the Board report on Inter-utility Cooperation, utilities should not only establish their own transmission access and wheeling policies but should cooperate with a view to establishing comprehensive policies generally acceptable to all utility members. Moreover, industry standards developed by the utilities should take into consideration transmission access and wheeling for non-utility generators, including independent power producers. These matters will have to be addressed as greater reliance is placed on such alternative supply sources to meet expected load requirements.

While the development of individual policies would provide transmission access and wheeling to others on terms developed by each utility, it would not, on its own, guarantee that mutually-agreeable commercial arrangements between participants could be struck. Establishment of a committee within the regional planning entity to oversee development of an industry standard would provide a forum for utilities to compare their individual policies with the aim of seeking commonality and eliminating differences.

As in Option B, individual policies and industry standards, as well as voluntary negotiated agreements, would be filed with a federal agency for public information and could be used by other interested parties. This option would not require the development of new regulations by the federal government.

OPTION D - Voluntary Negotiations with Non-Binding Arbitration

This option is an extension of Option C. In this case, the added dimension would be the establishment within each regional planning entity of a dispute resolution mechanism which would include non-binding arbitration. Any member could request a hearing before its peers. Under all circumstances other members, who are most knowledgeable of the technical, economic and financial factors involved, would be in control of the dispute resolution process. Therefore, this option would not involve any intervention by the federal and provincial governments. It would rely, essentially, on the good offices of other members not involved in the dispute to hear the complaints, to suggest equitable and fair solutions and, as appropriate, to apply peer pressure to resolve these matters.

This option would rely principally on cooperation, good faith and appropriate peer pressure by unbiased parties to reach solutions. Although it would not provide guarantees that commercial arrangements would be achieved, it would, nevertheless, provide the framework to distinguish and expose real, honest differences as opposed to those resulting from arbitrary and capricious actions.

The arbitration mechanism described here would be set up within the regional planning entities with industry personnel not involved in the disputes acting as arbitrators. Another alternative would be to rely on a non-governmental body, unrelated to the regional entities or their members, to be the arbitrator.

OPTION E - Binding Arbitration

This option takes the dispute resolution mechanism a step further. If it was believed in advance that resolution of conflicts would not be possible under the process described in Option D, then members of the regional planning entities could elect binding arbitration as a means of forcing a solution. In all other respects the dispute resolution process would be identical to the previous option. The fundamental difference would be that, under this option, members would have to agree beforehand that they would accept the judgement of the arbitrators.

The advantage of this option over the previous one is the strong likelihood that members would come before the disputes panel only with their very best technical, economic and financial arguments to prove their case. Added to this is the near certainty that the panel, consisting of industry peers, would never render a solution which they themselves would not accept for their own organization.

On the other hand, with binding arbitration there would be potential to adversely affect cooperation in other areas. In a real sense, resort to binding arbitration would be a recognition of failure between the parties involved to reach equitable solutions through cooperation, good faith and mutual respect.

OPTION F - Political/Regulatory Process

Under this option and the next, utilities and/or non-utility generators which were still unable to conclude commercially-satisfactory wheeling arrangements could seek redress outside of these organization through a federal agency with authority to mandate a solution.

This option proposes that such a federal agency only be allowed to exercise such powers when specifically directed to do so by the federal government on a case-specific basis. Such a process is not unlike the present authority of the Board in respect of construction and operation of interprovincial power lines under Section 58(4) of the NEB Act. In effect, the Governor in Council may now designate an interprovincial power line as a facility that is to be constructed and operated under and in accordance with the provisions of the NEB Act. Although Section 58(4) has never been applied, it does however provide an avenue of final resort. This, in and of itself, could add impetus and incentive for the parties involved to voluntarily reach mutually-satisfactory arrangements rather than face the prospects of a federally-mandated solution. This option would require changes to the NEB Act and its regulations.

OPTION G - Regulatory Process

This option is similar to Option F with one significant difference. Parties that could not reach acceptable transmission access and wheeling arrangements would be able to seek redress by making application directly to a federal agency such as the Board. As with Option F, this option would require changes to the NEB Act and its regulations.

FOREWORD

The federal government's "Canadian Electricity Policy" dated September 1988 focused on new initiatives with respect to the regulation of electricity exports and the construction and operation of international power lines. In that year the federal government also established an Energy Options Advisory Committee whose purpose was to canvass Canadians in order to develop a comprehensive energy options plan into the next century. In the fall of 1988, this committee released its report entitled "Energy and Canadians: Into the 21st Century", which stated that "the Government of Canada has a crucial leadership role to play in eliminating barriers to interprovincial trade". The Committee made two particular suggestions:

- electrical energy generation should be organized on a cooperative interprovincial scale when economically viable; and
- the Government of Canada should articulate the conditions under which one province has a right to access, on a business basis, another province's electricity corridor or electrical grid for the purpose of transmitting electricity to a market not adjacent to the first province.

The federal government acknowledged that a number of difficult practical and jurisdictional questions would have to be addressed before it could decide whether it was necessary to take specific policy actions in these areas. Accordingly, the Minister of Energy, Mines and Resources requested the National Energy Board to review the role that the federal government might play in eliminating barriers to interprovincial electricity trade. Specifically, the Minister asked the Board to undertake a review and report on possible measures to:

- enhance interprovincial trade in electricity;
- encourage greater cooperation between utilities in systems planning and development; and
- enable buyers and sellers of electricity to obtain commercial access to available transmission capacity through intervening provinces for wheeling purposes.

In undertaking this review, the Board decided to carry it out along two separate tracks. The first track, which focused on inter-utility cooperation, is the basis of a separate report. The second, which addressed questions relating to transmission access and wheeling, is the basis of this report.

It was clear to the Board that in undertaking the review of transmission access and wheeling, it would be necessary to gather and analyze much data and information on the history and present status of these types of transactions in North America, as well as to assess the technical and economic problems which would have to be dealt with if wheeling were to take place. Accordingly, the Board engaged Casazza, Schultz & Associates, Inc., of Washington, D.C., to prepare a report entitled "Concepts and Principles of Wheeling among Interconnected Electric Utilities". Also, in order to show that there were, in fact, economic benefits which could be realized through wheeling, the Board carried out a study using its CANEBEX5 computer model to quantify the benefits of wheeling economy energy in those parts of eastern Canada and the northeastern U.S. which make up the Northeast Power Coordinating Council (NPCC). The Casazza, Schultz report and the results of the CANEBEX5 analysis were forwarded to the provinces, Canadian utilities and other interested parties in December 1990, along with the results of the studies undertaken as part of the review of Inter-utility Cooperation, for their examination and comment. A series of meetings was held in the spring/summer of 1991 between Board staff and representatives of the provinces and utilities to review the material provided. Information arising from these discussions and comments received subsequently were incorporated into and form an integral part of this report.

The Board, as part of the consultative process, intends to solicit comments from interested parties on the results of these preliminary investigations. These consultations will lay the foundation for productive dialogue on the options available to enhance interprovincial trade in electricity.

ACKNOWLEDGEMENTS

This report would not have been possible without the full participation of the provincial governments and Canadian electrical utilities. The Board gratefully acknowledges their contributions, as well as that of Casazza, Schultz & Associates, Inc., which form the basis of much of the technical information contained in this report.

OUTLINE OF REPORT

Chapter 1 describes the evolution of wheeling in Canada. The historical context is first established and then the current status of wheeling is described.

Chapter 2 examines the concepts and principles of wheeling. It describes the technical and institutional impediments to wheeling and discusses the economic issues associated with it. The impact of wheeling is examined in terms of its effect on system operations and planning. The chapter describes wheeling arrangements in the United States and compares these with the existing situation in Canada. It shows that, since each utility has a mandate to supply its own load requirements, there has been little or no interest by Canadian utilities to enter into wheeling transactions. There is, however, a growing interest in utilizing revenue from sales to other provinces and to the U.S. to reduce electricity costs to native customers, and in advancing the construction of generation to supply loads in other service areas until it is needed to supply local demand. Wheeling would be required to effect many of these transactions. The material in Chapter 2 has been extracted from the report prepared by Casazza, Schultz & Associates, Inc.

Chapter 3 describes a study carried out by the Board to quantify the potential benefits from wheeling of economy energy in the interconnected system of the Northeast Power Coordinating Council (Ontario, Québec, the Maritimes, New York and New England) using its CANEBEX5 computer model. The study showed that the total network benefit increased by up to 10 percent when wheeling took place. The change in the total thermal energy generated in the network and its cost in the cases where no economy exchanges took place showed that wheeling reduces the overall thermal generation and the corresponding cost.

Chapter 4 suggests principles which could serve as guidelines for arranging wheeling services and proposes an approach to wheeling in Canada. It goes on to describe a range of feasible options for consideration by interested parties that would improve access to transmission and wheeling services in order to achieve greater interprovincial and international trade in electricity.

1. EVOLUTION OF WHEELING IN CANADA

1. EVOLUTION OF WHEELING IN CANADA

1.1 Historical Context

The potential benefits of wheeling[1] have long been recognized in Canada. However, the technical problems associated with wheeling on a large scale, as well as political considerations, have kept it from becoming a reality.

Wheeling was an integral part of the concept of a national grid which was first proposed by Prime Minister John Diefenbaker in 1959. He visualized a "National Energy Grid anchored at one end on the Hamilton River in Newfoundland and at the other by the Columbia and the Taku in British Columbia". While recognizing that technical problems associated with the long-distance transmission of power stood in the way of this vision, he was confident that these would be overcome and that large blocks of inexpensive power could be "bumped" and "wheeled" from surplus areas to deficit areas across the land.

In 1960, the Minister of Northern Affairs and Natural Resources called for a trans-Canada electricity grid that would serve to distribute power across the country and would also provide the basis for the development of great reserves of power in remote areas in the north. Support for this concept was expressed by Saskatchewan, New Brunswick, Ontario and Manitoba.

By 1962 there was enough momentum behind the idea for a Federal-Provincial Conference on Long Distance Power Transmission to be held. The purpose was to assess the advantages of interregional interconnections, to discuss ways of solving the problems associated with long-distance transmission, and to define the roles that the two levels of government could play in the planning and research needed to bring about such a development. While Québec did not attend and Newfoundland indicated reservations, the participants in the Conference established a working committee to organize a National Power Network Study which was to: define the backbone of a trans-Canada electricity interconnection; assess its probable benefits and costs; and carry out detailed technical and economic studies as required.

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[1] Wheeling is defined as the authorized use of transmission facilities of an intervening entity by two other entities whose own transmission facilities are not directly interconnected with each other, in order to sell, purchase or interchange electricity between themselves.

The study examined the merits of a coast-to-coast high-voltage transmission line which would proceed along a southern route from Halifax to Vancouver with provisions for incorporating the hydroelectric resources of the Peace River in Alberta, the Nelson River in Manitoba and Churchill Falls (then known as Hamilton Falls) in Labrador. The development of these hydroelectric sites would permit the deferral of coal-fired generation in the Prairies and the Maritimes. The study concluded that such a project would facilitate the development of Canada's remote hydroelectric resources and would yield substantial benefits to the national and provincial economies.

While the study was in progress, the original terms of reference were expanded to include consideration of regional electricity networks as possible intermediate stages between independent provincial systems and a full-scale national grid. This would permit the realization of many advantages of the national grid without some of the disadvantages. In addition, some of the reasons for a national grid were being overtaken by events such as the Nelson River and Churchill River hydroelectric developments moving forward independently. These factors, together with the fact that the estimates of net benefits of the overall scheme were quite sensitive to that assuptions made, contributed to the decision of the Federal-Provincial Working Committee that no new initiative towards a national grid be undertaken.

Although the national grid concept would be promoted again, interest had shifted to regional networks and the development of export markets. In 1974, the federal government adopted a policy to support the strengthening of regional interconnections. When the provinces endorsed the notion of a national grid again that year, the federal government responded that any national grid initiative would have to come from the provinces. This initiative resulted in a second national grid study under the auspices of the Interprovincial Advisory Council on Energy (IPACE) in 1977. As a result of this study, IPACE concluded that, at that time, the net benefits of strengthened interconnections involved in forming a national grid did not justify their installation.

Subsequently, regional developments such as the Western Grid involving British Columbia, Alberta, Saskatchewan and Manitoba; the Eastern Grid involving Ontario, Québec, Newfoundland, New Brunswick, Nova Scotia and Prince Edward Island; and the Maritime Energy Corporation involving the three Maritime provinces received detailed consideration and study but were not realized. These developments, had they in fact come about, would have depended extensively on wheeling to realize the potential benefits for the utilities involved.

As a result of this sequence of events, wheeling in Canada today is done only in isolated cases and on a small scale. These cases include the following situations. B.C. Hydro engages in some wheeling to expedite its export trade. New Brunswick Power wheels power from the New England Power Pool (NEPOOL) through its system to neighbouring Maine utilities which have no direct interconnection to NEPOOL and also wheels power through its neighbour, Maine Public Service, for return in another part of the province. New Brunswick Power also wheels electricity from Hydro-Québec through its system to Maritime Electric in Prince Edward Island under paired purchase/sale agreements, and this is the sole example in which all parties involved in an existing wheeling transaction are Canadian utilities.

1.2 Current Status of Wheeling

Historically, wheeling has not formed any significant part of Canadian inter-utility transactions. The amount of wheeling performed is trivial compared to total inter-utility energy transfers. For example, in 1988 the total interprovincial and international energy transfer was 77,679 GW.h of which only 3% (2,493 GW.h) involved wheeling. Commercial wheeling amounted to 1.8% and the remaining 1.2% was for the purposes of border accommodation.

The lack of wheeling in Canada, can be attributed to three main factors as described below:

- Utility Mandates - Most of the major utilities are provincially-owned and were established to supply electricity within their home provinces. In general, they have maintained adequate capacity to do this within each province.

- Geography - In total, there are 16 major utilities in Canada. Generally, each supplies a relatively large number of consumers and covers a large geographical area. With a few exceptions, the utilities are arranged in an east-west chain. Generation and load is concentrated within each provincial service area and interconnection capacity between provinces is usually smaller than with neighbouring utilities in the U.S.

- Interconnection Facilities - The North American power system is made up of interconnected utilities as shown in Figure 1.1 In practice, the Canadian portions of the system can be divided into four blocks which cannot operate in synchronism and are, therefore, connected by DC transmission systems.

These blocks are:

- British Columbia and Alberta (Western Systems);
- Saskatchewan, Manitoba, Ontario, New Brunswick, Nova Scotia and Prince Edward Island (Eastern Systems). (There is a potential connection through the United States Eastern Interconnection between Saskatchewan, Manitoba, Ontario, and the Maritimes. However, there are no transactions among Canadian utilities over this route.);
- Québec and Labrador; and
- the Island of Newfoundland (not shown).

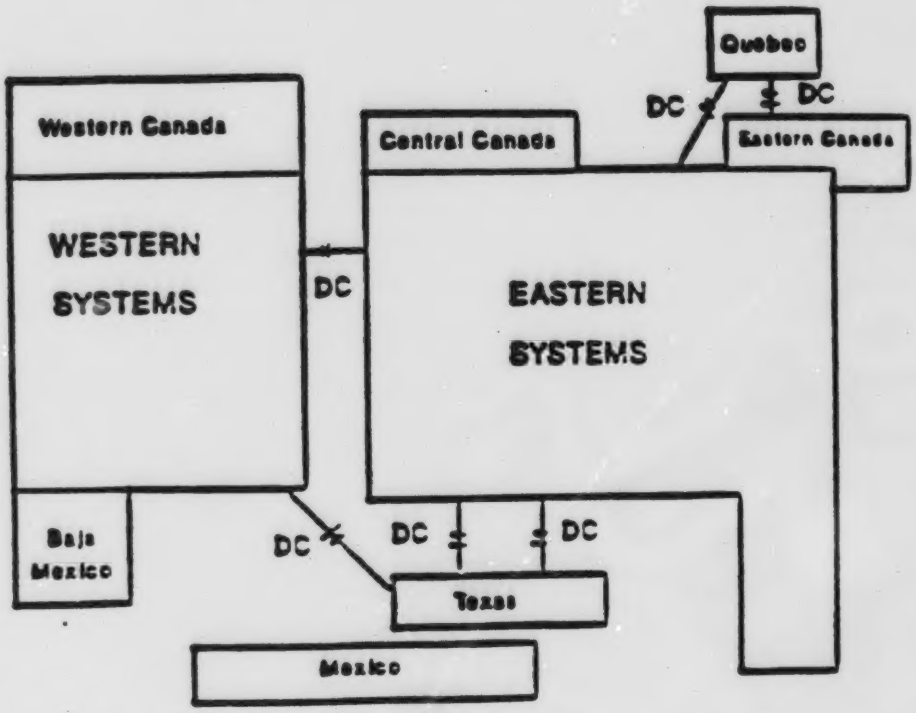
The following observations can be made from Figure 1.1:

- Nova Scotia and Prince Edward Island can exchange energy with other systems, Canadian or American, only through New Brunswick;
- Alberta is connected to the U.S. Western Interconnection through British Columbia;
- the Island of Newfoundland is not connected to any other system; and
- Labrador is connected to the Canadian system through Québec.

These observations indicate that, from an energy transfer point of view, British Columbia, Québec and New Brunswick are in advantageous geographical positions whereas Alberta, Nova Scotia and Prince Edward Island are in less beneficial positions.

Figure 1.1

THE FIVE SYNCHRONOUS SYSTEMS OF NORTH AMERICA


Quebec
DC
DC
Western Canada
Central Canada
Eastern Canada
WESTERN SYSTEMS
DC
EASTERN SYSTEMS
Baja Mexico
DC
DC
DC
Texas
Mexico

Newfoundland, through its possible developments in Labrador, could gain some potential for energy transfers through Québec.

One of the most prominent cases in which wheeling may have led to different results was the development of Churchill Falls in Labrador. In the end, without a wheeling or transmission access option being available to it, Newfoundland entered into financing and sales agreements with Hydro-Québec.

1.3 Newfoundland/Federal Government Discussions on Wheeling

In the early 1980's, discussions were held between the federal government and Newfoundland on the idea of incorporating a wheeling amendment into the National Energy Board Act. There were two principal objectives behind these discussions:

- to review the Churchill Falls Power Contract already in place; and

- to establish a wheeling opportunity through Hydro-Québec's system for future developments.

The discussions concentrated on legislation that would :

- permit the Board to authorize the construction and operation of an interprovincial transmission line including expropriation powers, as necessary;

- permit the Board to require, and to set conditions for, the transmission of electric power across provinces through existing transmission systems in the case where surplus transmission capacity exists or utility systems mutually agree to proceed. The proposed legislation would not have compelled the wheeling utility to construct additional transmission capacity for wheeling; it would only have provided for wheeling as long as there was surplus transmission capacity; and

- permit the Board to require the transmission of electric power across provinces even if the wheeling utility would be required to construct additional facilities for the purpose of wheeling.

Following some discussion, the federal government established *The Energy Security Act* which, among other amendments to the *National Energy Board Act*, granted the Board specific authority to permit the expropriation of land for construction of any interprovincial power line which is designated by the Governor in Council. No such designation has taken place so far.

Bill C-108, *An Act to amend the National Energy Board Act* was proclaimed on 1 February 1983. This Act included a provision to designate particular interprovincial transmission lines for treatment as if they were international power lines - giving the Board jurisdiction over the regulation of such lines and over the expropriation of land for their construction.

1.4 National Energy Board Inquiry

In September of 1986, the Minister of Energy, Mines and Resources asked the Board to review and report on changes that could be made to simplify and reduce the federal regulation of electricity. The Board at that time issued export orders or licences authorizing exports of electricity; issued certificates approving the construction and operation of international power lines over which exports were made; and approved the detailed routes for these facilities.

In response to the request the Board decided, as part of its overall inquiry, to hold a public hearing to obtain the views of interested parties on issues relating to the regulation of electricity exports and international power lines.

In respect of wheeling and transmission access, discussions took place on situations in which Canadian utilities with surplus power to export do not have direct transmission access to U.S. markets. Access would then only be possible through the transmission facilities of other utilities or by construction of separate transmission facilities traversing another province en route to the U.S.

Some interested parties expressed views on gaining access to U.S. markets by means of Section 90.1 of the National Energy Board Act, which allows the Governor in Council to designate any facility to be constructed for the purpose of transmitting power from a place in the province to a place in Canada outside that province as a facility to which the provisions of the National Energy Board Act would apply.

The panel identified the following options regarding amendments to the National Energy Board Act relating respectively to the wheeling of exports, and to access purpose-built lines for export:

- amend the Act to provide for federal regulation of transmission access to wheel electricity exports;
- amend the Act to provide for federal regulation of transmission access to wheel electricity exports but provide for relevant sections to be proclaimed at a later date if utilities fail to reach agreement;
- amend the Act to make explicit the Board's jurisdiction over the construction and operation of export-dedicated lines traversing an adjoining province;
- amend the Act to make explicit that the Board does not have jurisdiction over the construction and operation of export-dedicated lines traversing an adjoining province; and
- maintain the status quo.

1.5 Energy Options Inquiry

In April 1987, the Minister of Energy, Mines and Resources initiated the Energy Options inquiry with the aim of conducting a comprehensive review of Canadian energy issues, examining the present energy situation, and attempting to identify and evaluate future options. A 23-member Advisory Committee was appointed to carry out the review.

To encourage debate and elicit the expertise and opinions of Canadians, the Advisory Committee held a series of seven conferences and seminars in different parts of Canada to which some 700 energy producers, consumers, special interest groups and officials were invited. It commissioned papers to review current research, distributed information posters through daily newspapers to stimulate public discussions, and invited responses to a pamphlet entitled, "The Energy Question".

The report of the Advisory Committee on Energy Options entitled "Energy and Canadians: Into the 21st Century" was released in August 1988. The report outlined a set of principles which the committee recommended that the federal government adopt to guide future energy policy. It covered all aspects of energy in Canada, including development, security, environment, markets, the fiscal system, efficiency and technology. The report included observations on such topics as trade, northern development, federal-provincial matters, megaprojects and nuclear power generation.

In regard to interprovincial trade and wheeling, the report stated that, "the Government of Canada has a crucial leadership role to play in eliminating barriers", and made two particular suggestions:

- electrical energy generation should be organized on a cooperative interprovincial scale when economically viable; and

- the Government of Canada should articulate the conditions under which one province has a right to access, on a business basis, another province's electricity corridor or electrical grid for the purpose of transmitting electricity to a market not adjacent to the first province.

Based on the recommendations of the Energy Options report, the Minister of Energy, Mines and Resources initiated the Inter-Utility Trade Review for identifying measures to enhance cooperation and encourage transmission access among Canadian utilities.

1.6 Inter-utility Trade Review

The Minister of Energy, Mines and Resources requested the Board to undertake a review and report on possible measures that can properly be taken to:

- enhance interprovincial trade in electricity;

- encourage greater cooperation between utilities in systems planning and development; and

- enable buyers and sellers of electricity to obtain commercial access to available transmission capacity through intervening provinces for wheeling purposes.

To identify measures for enhancing transmission access in Canada, the Board initiated two projects:

- a study of the technical issues associated with wheeling; and
- quantification of certain potential benefits made available by wheeling.

The first project dealt with the technical and economic difficulties associated with wheeling and methods to alleviate these difficulties, while the second used computer simulations to quantify some of the potential short-run benefits of wheeling economy energy in eastern Canada and the northeastern U.S.

2. CONCEPTS AND PRINCIPLES OF WHEELING

2. CONCEPTS AND PRINCIPLES OF WHEELING

This chapter is a summary of the report to the National Energy Board entitled "Concepts and Principles of Wheeling among Interconnnected Electric Utilities", dated August 31, 1990, which was prepared by Casazza, Schultz and Associates, Inc..

2.1 Electric System Operations and the Issue of Transmission Access and Wheeling

Electric power systems do not create energy. They convert energy from one form to another and deliver it from the location of its source to where it is to be used. To do this, electric power systems have generators, which convert the source energy to electricity, and transmission which integrates these generation sources and delivers the energy.

An overall excellent summary of the components of the electric power system was presented in the report to the U.S. Congress by the Office of Technology Assessment [2], as follows:

ELECTRIC POWER SYSTEMS

> An electric power system is comprised of: generating stations to produce electricity; transmission lines to transport electricity over long distances; distribution lines to deliver the electricity to customers; substations to connect the pieces to each other; and control centres to coordinate operation. Fossil fuels, nuclear fission, and falling water are commonly used in the generating units.
>
> Generating units typically produce 60 cycles/second (Hertz or Hz) alternating current (AC) electricity with voltages between 12 and 30 kV. The frequency of all generating units on a system must be precisely synchronized. Generating units have automatic voltage regulators which control the voltage output and speed governors which adjust the power output in response to changing system conditions. In addition to real power, reactive power, or VAR's, must be monitored and controlled to maintain voltage.

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[2] Page 10, U.S. Congress, Office of Technology Assessment, ELECTRIC POWER WHEELING AND DEALING: TECHNOLOGICAL CONSIDERATIONS FOR INCREASING COMPETITION,U.S. Government Printing Office, Washington, D.C., May 1989.

Transmission lines carry electric energy from the power plants to the distribution systems. Most transmission consists of overhead AC lines designed to operrate at voltages between 69 and 735 kV. Power transformers raise the generator voltage to the transmission voltage and back down to the distribution network level (typically under 35 kV) at the other end. There are some segments of direct current transmission and underground cables for special applications but these are less common than overhead AC lines.

An interconnected group of transmission lines comprises a transmission system. Virtually all utilities are connected to neighbouring utilities through one or more lines of a transmission system. Coordinated operation of the power system is implemented through control areas. A control area is a geographic area with a control centre responsible for operating the power system within that area. One or more utilities may make up a control area.

Control centres employ a variety of equipment and procedures: monitoring and communication equipment called telemetry to inform the centre of generator output and system conditions; and computer-based analytical and data processing tools which together with engineering expertise specify how to operate generators and transmission lines. The equipment and procedures are typically organized into three somewhat overlapping systems which are sometimes integrated in a full energy management system. They are the automatic generator control system which coordinates the power output of generators; the supervisory control and data acquisition system which coordinates the transmission line equipment and generator voltages; and an analytical system to monitor and evaluate system security and performance and plan operations.

Control areas generally operate in synchronism, directly connected to each other, so that a loss of generating capacity or increase in load in one area is covered by increases in generation throughout the entire system. Each of these synchronous systems in reality constitute a single machine spread over a large geographic area.[3] There are five such synchronous systems supplying all of North America, as shown in Figure 1.1 in Chapter 1.

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[3] Thomas P. Hughes, "SYSTEM BUILDERS, TECHNOLOGY'S MASTER CRAFTSMEN," CIGRE *Electra*, No. 109, December 1986.

2.1.1 Reliability

Electricity cannot be stored; the production and consumption of electric energy must be simultaneous. Consequently, reliability is very important to system operators and planners.

The North American Reliability Council (NERC) has defined reliability in two components.[4]

- adequacy - the availability of sufficient generating capacity and energy resources (e.g., fuel, or water for hydro plants) to meet normal needs; and

- security - the ability of the system to withstand losses of major components (e.g., a generator, transformer, or transmission line) and continue to provide proper service.

The ability to meet normal system needs requires that sufficient generating capacity be installed to meet peak system demand throughout the year even when equipment breaks down, typically called "forced outages," and when equipment is removed from service for routine maintenance, called "scheduled outages." These outages may be in the generating plants or in the transmission system. Reserves in both generation and transmission are needed to cover these outages.

The system requirement to supply electricity is measured in two ways:

- the maximum load or demand which must be supplied at any one time; this demand is measured in kilowatts (kW) or megawatts (MW). A megawatt is 1,000 kilowatts; and

- the total amount of energy which must be provided over a period of time; this energy use is measured in kilowatt-hours (kW.h) or megawatt-hours (MW.h).

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[4] 1989/1990 WINTER ASSESSMENT, North American Electric Reliability Council, 1989.

To meet the maximum load demands, the power systems must both install and operate sufficient generating capacity. At any time, system generating capacity is the summation of the net dependable capacity[5] of each generator unit which can be delivered to the system.

To meet overall system energy requirements, sufficient hydroelectric, fuel, or other resources must be available. This requires the proper scheduling of the use of hydroelectric resources and having the proper fuel reserves in storage. The term energy indicates the amount of electricity which has been, or can be, produced over a period of time.

Besides the continuity of service, the electricity consumer requires that power be delivered at the proper voltage if his equipment is to operate at its maximum efficiency and avoid damage. Because of the nature of electric power systems, proper voltage cannot be provided unless adequate supplies of "reactive power" are provided at all times. The provision of reactive power does not require the use of energy resources or the use of any megawatt capacity of the generators. It is provided by devices known as capacitors, by the "magnetic fields" in the generators, and by certain other systems components. [6]

2.1.2 The Transmission System

In North America, the vast majority of transmission lines are alternating current (AC) lines.

In each synchronous area, networks of transmission lines interconnect the various generating plants and connect these plants to the load or delivery points. At these delivery points, the power is transformed to lower voltages and distributed to consumers.

AC transmission networks are complex and must be carefully designed and operated so as to withstand various generator and transmission contingencies under continuously changing load conditions. Unlike telephone systems, gas systems, and water systems, electric power cannot be directed or controlled to flow over prescribed transmission paths. The power will divide at all times among the various paths based on the laws of engineering known as Kirchoff's Laws. In addition, as discussed above, the electricity required must be produced and delivered the same instant it is needed. The product cannot be stored in a "warehouse" for future potential use.[7]

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[5] Page 77, EQUIPMENT AVAILABILITY REPORT, North American Electric Reliability Council (NERC), 1983.

[6] ELECTRIC UTILITY SYSTEMS AND PRACTICES, 4th Edition, ed. by Homer Rustebakke, New York, New York, 1983.

The capacity of an AC transmission system[8] to deliver power is also a complex matter and depends on the network arrangement, size and type of conductors, lengths of lines, the location and size of generation sources and loads, etc. The network capacity may be limited by transient or steady-state stability conditions for longer lines, voltage instability, or the thermal heating of conductors. The capability of circuit breakers and protective systems must be checked as new generators are added and system changes are made. These factors require that many technical analyses be made by skilled engineers to determine the capacity of a transmission network.[9]

AC lines are used because they are usually cheaper and much easier to connect in reliable networks than DC lines. In special cases however, particularly where large blocks of power must be transmitted over long distances, or when large synchronous areas must be interconnected with only a few tie lines, D.C. lines may be advantageous. D.C. lines have an advantage over AC lines in that the amount of power flowing over each line can be controlled to a specified value.

2.1.3 Economic Dispatch

The incremental production cost of a generating unit is the additional cost per kilowatt-hour of generating a small additional quantity of energy from that unit or the cost reduction per kW.h due to generating a lesser quantity of energy. Generally, this incremental cost consists mostly of additional fuel costs, but it also includes any other operating costs that vary with the level of power production. The incremental cost of a generator is determined almost entirely by the cost of its fuel and how efficiently it converts that fuel into electric power. For a typical thermal unit, the incremental cost increases as production increases from the minimum to the maximum rated output. The incremental cost of a unit is not the same as its average cost, which generally decreases as it output increases.

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[7] "UNDERSTANDING THE TRANSMISSION ACCESS AND WHEELING PROBLEM," J.A. Casazza, Public Utilities Fortnightly, Oct. 31, 1985.

[8] Page 6-7, "TRANSFER CAPABILITY - A REFERENCE DOCUMENT," National Electric Reliability Council (NERC), October 1980.

[9] ELECTRIC UTILITY SYSTEMS AND PRACTICES, 4TH EDITION, ed. by Homer Rustebakke, New York, New York, 1983.

Economic dispatch consists of supplying the system's total power requirements at any time by loading each available generating unit to the point where its incremental cost is the same as that of all other generation. Units whose highest incremental cost is lower than this common incremental cost are, of course, loaded to their maximum capability.

Today's electric power systems are being dispatched and operated based on the incremental costs of production. This general practice often results in one utility producing electricity for use by some of another utility's customers when the first utility can produce the incremental power at a lower cost. This leads to maximum economic efficiency in the use of the investment and in the cost of operating these systems . No other industry operates in this way, whereby all suppliers work together to produce a common product, using plants which have the lowest incremental cost to produce the additional units of energy needed regardless of plant ownership.
The only exception to this production based on incremental costs has resulted from the recent addition of cogenerators and qualifying facilities. The proposed addition of independent power producers could increase further the amount of generation that is not economically operated based on incremental production costs.

2.1.4 Transmission Constraints

In performing economic dispatch to minimize total power production costs, the limitations on the transmission system's capability to transfer power reliably must be observed. If economic dispatch causes too much power to be transferred from one area to another, it is necessary to reduce the output of units in the sending area, and increase the output of units in the receiving area. This deviation from economic dispatch in order to observe transmission constraints causes a cost increase due to those constraints.

It is important to note that inter-utility transactions are implemented simply by increasing the generation of the selling utility and decreasing that of the buying utility. When two systems are connected to each other by more than one AC transmission link, whether directly or indirectly through other utilities, it is not possible to direct a power interchange along a specific link. The power flows between the systems in accordance with the physical laws that govern the flow of electricity. A detailed discussion of

"Physical Impediments to Transmission" can be found in the Supplement to the Casazza, Schultz & Associates Inc. report to the National Energy Board.

In summary, transmission constraints exist beyond which the transmission system is not capable of safely transmitting additional power even though it would be economic to do so. The effect of transmission constraints is to reduce reliability or increase the required generating reserves. The transmission constraints may also increase total production costs by interfering with economic power system operation and, in particular, with the practice of economic dispatch.

2.1.5 Control Areas and Functions

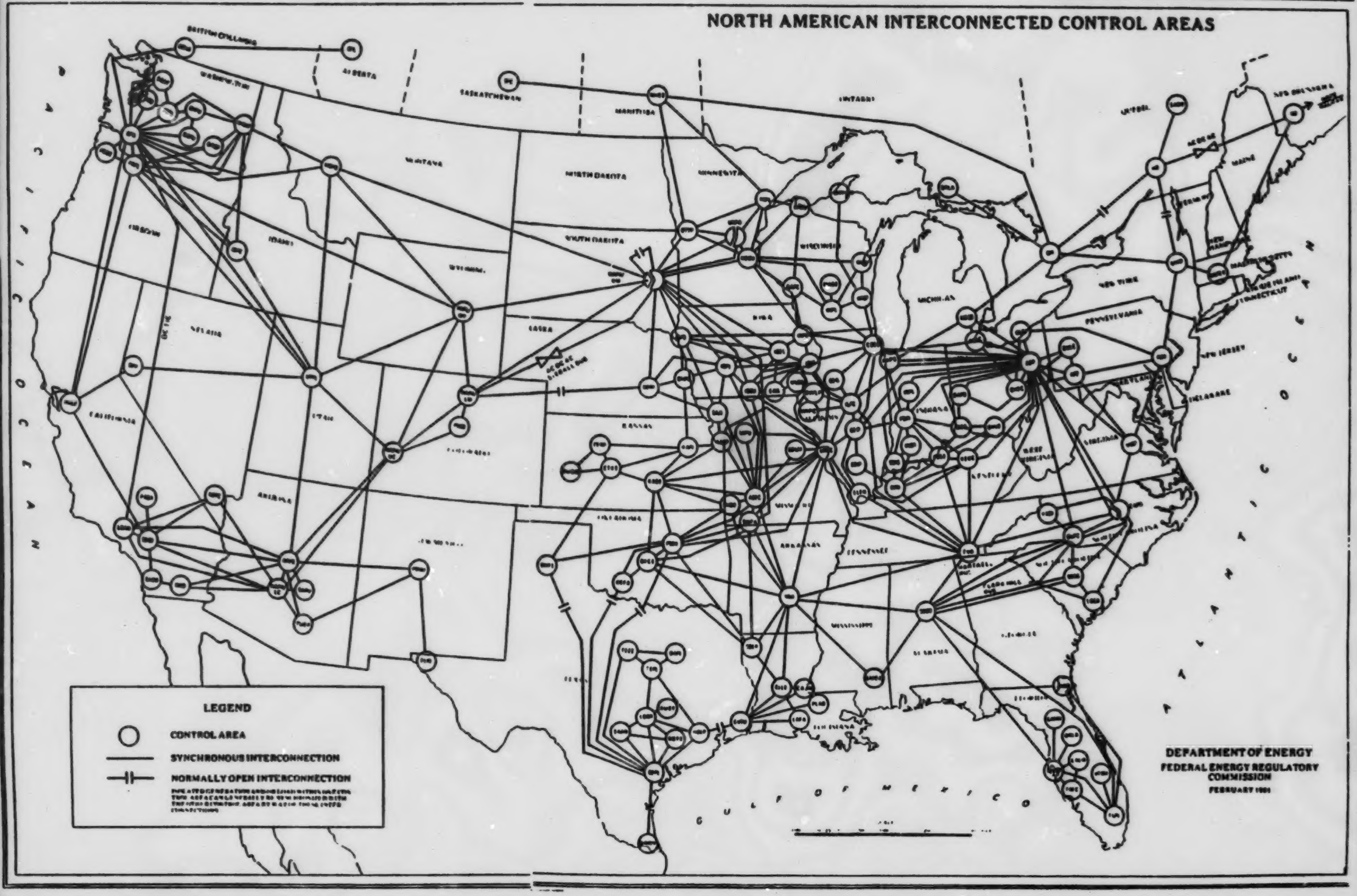
Electric utilities are connected to neighboring utilities through one or more transmission links. Unless contrary arrangements are made, it is the responsibility of each utility to provide the power used by its customers without absorbing power from its neighbors or sending unwanted power to them. This general principle is implemented through the institution of control areas.

A control area is a utility or group of utilities with the following characteristics:

- the total power flow between the control area and neighboring control areas is monitored by the control area operating centre; and
- automatic controls adjust the output of generators inside the control areas in such a way that the total power transferred across the borders of the control area is equal to the net sales or purchases transacted between the utilities inside and outside the control area. This is called the control of tie line loadings.

Every utility in Canada and the United States is, or is a part of, a control area. The operation of control areas ensures that the utilities within the control area, taken as a group, fulfill their responsibility of providing for their own loads and carry out scheduled transactions with other systems. While they cannot ensure specific flows on specific transmission lines, they do provide a form of control in the sense that the total flows out of or into a control area can be specified. A map of the principal control areas in Canada and the United States is shown in Figure 2.1.

Figure 2.1


NORTH AMERICAN INTERCONNECTED CONTROL AREAS
BRITISH COLUMBIA
ALBERTA
SASKATCHEWAN
MANITOBA
ONTARIO
QUEBEC
NEW BRUNSWICK
WASHINGTON
MONTANA
NORTH DAKOTA
MINNESOTA
OREGON
IDAHO
SOUTH DAKOTA
WYOMING
WISCONSIN
MICHIGAN
NEW YORK
MAINE
VERMONT
MASSACHUSETTS
CONNECTICUT
RHODE ISLAND
PENNSYLVANIA
NEW JERSEY
DELAWARE
MARYLAND
NEVADA
UTAH
COLORADO
NEBRASKA
IOWA
KANSAS
INDIANA
WEST VIRGINIA
VIRGINIA
KENTUCKY
CALIFORNIA
ARIZONA
NEW MEXICO
OKLAHOMA
ARKANSAS
TENNESSEE
NORTH CAROLINA
SOUTH CAROLINA
MISSISSIPPI
ALABAMA
GEORGIA
TEXAS
LOUISIANA
FLORIDA
PACIFIC OCEAN
ATLANTIC OCEAN
GULF OF MEXICO
LEGEND
CONTROL AREA
SYNCHRONOUS INTERCONNECTION
NORMALLY OPEN INTERCONNECTION
DEPARTMENT OF ENERGY
FEDERAL ENERGY REGULATORY COMMISSION
FEBRUARY 1981

Control areas cooperate with each other to maintain the power supply frequency at 60 Hz by adjusting their generation whenever the frequency begins to deviate from this standard. Transmission capacity must be reserved for this function since frequency deviations are generally caused by the loss of a major power source, such as a complete power plant, which will cause major power inrushes throughout an extensive geographic area. For example, if a large generator trips out in the state of Georgia in the USA, a small portion of the lost generating capacity will be made up by Ontario Hydro's generators, thus increasing the loadings of the transmission tie lines delivering power from Ontario to the New York Power Pool.

2.1.6 The Changing Situation of Transmission Access in the USA

Transmission systems have been evolving in the U.S.A. for more than 100 years. For more than 60 years, transmission interconnections have existed among the utilities in North America. Contractual and regulatory procedures for the use of these interconnections have been successfully developed. Many wheeling arrangements have been successfully consummated.

Within the last few years, new driving forces have arisen in the USA, and worldwide, which have at their core the desire to improve the economic performance of electric supply systems through increased use of competition and market forces. [10]

2.1.7 Why More Competition?

The benefits of competition are well known. The desire to lower one's costs, to increase one's market share, and to improve earnings provide strong motivation. There are those who feel that the benefits of competition have not been fully achieved in the USA in the production, transmission, and distribution of electric power. These people are anxious to attempt innovative ways to achieve these benefits. These commentators propose that electric power be competitively produced and supplied to the system by non-utility

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[10] See for example:

a) Policy statement of ELCON (association of major industrial customers)

b) Publications of the Transmission Access Policy Study Group (representing a large number of municipally- and cooperatively-owned utilities

c) Statements by several companies engaged in the development of PURPA Qualifying Facilities and other independent power producing plants

d) FERC Dockets RM-88-4; RM88-5; RM88-6 - Notices of Proposed Rule Making, March 1988, and the many responses generators (NUGs). Others are also proposing a "common carrier" transmission system making possible a "free market" for the production and sale of electricity.

It is true that suppliers and purchasers of electricity must have access to the delivery system (i.e., transmission), if there is to be competition. But physically, there is only one transmission system. If there is to be competition, all suppliers and purchasers must have access to that system.

Transmission systems which are individually owned become a single system where interconnected. Disparate uses of that single system by many parties, each pursuing its individual interests, interact with each other with effects that can be detrimental to all. The control and coordination of all the various uses of the system is, obviously, in the common interest.

2.1.8 Other Driving Forces

It is difficult to present a single overall USA national view. State and regional problems can be different. In general, however, the fundamental forces for change in the USA are:

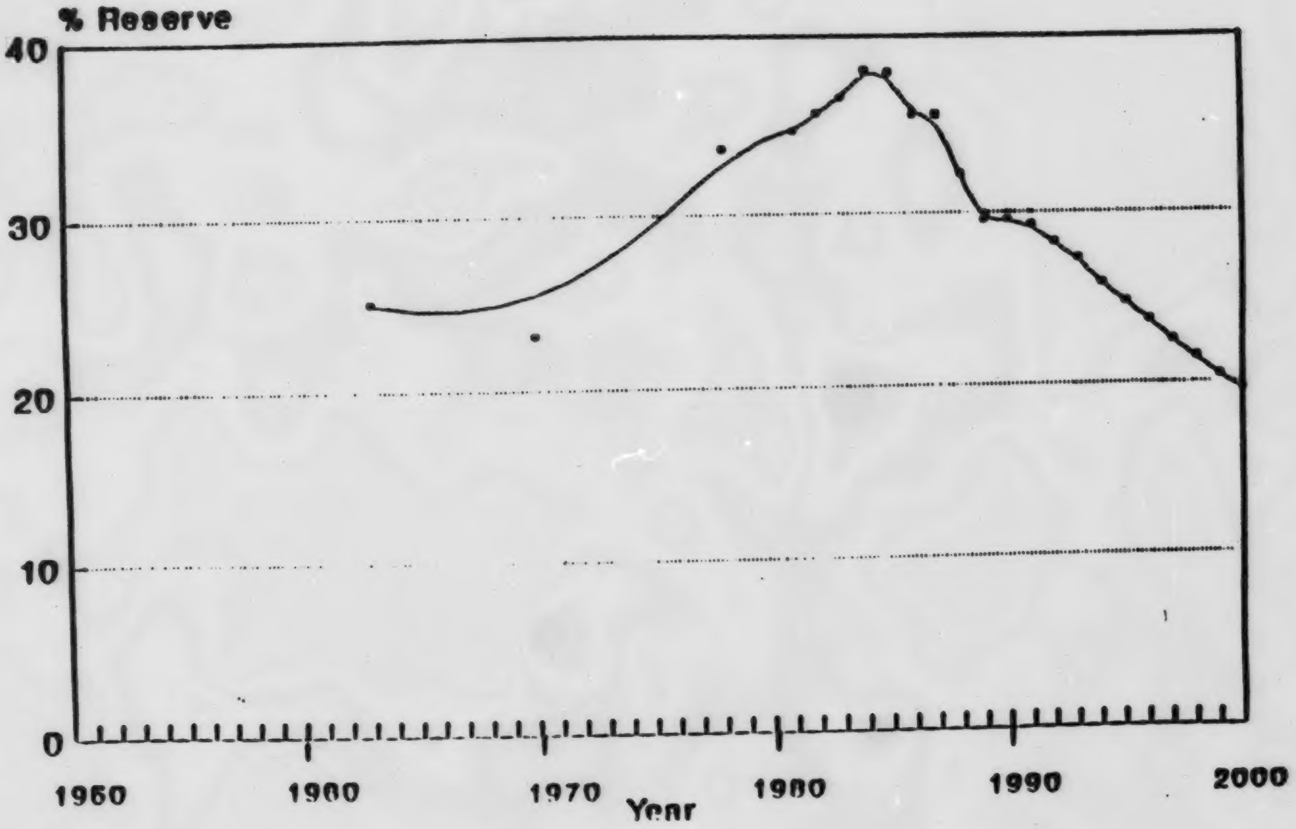
- Changing Economics

    1. Lack of any significant expansion of hydro resources, thus increasing competition for the low cost energy from these increasingly valuable resources.

    2. Ten years ago, the fuel cost differentials between types of fuel and regions were significant. At present, these differentials are lower than they have been for some time. There is a good chance that five years from now large fuel cost differentials will return if imported oil prices increase significantly.

    3. The surplus of generating reserves that exists at the present time will not exist five years from now. The excess generating capacity and energy available for sale to other systems will decrease significantly, as shown in Figure 2.2.

TOTAL RESERVE GENERATING CAPACITY
USA SYSTEMS



Data from "Electricity Supply & Demand", NERC, 1979 - 1980 editions, and from "National Power Survey", 1964 & 1970.

Figure 2.2

4. Nuclear plants are being completed and gradually phased into rate bases and the utilities are beginning to earn considerable amounts of cash as expenditures for new construction decrease, as shown in Figure 2.3.

5. The future USA utility financial picture may be considerably better than it is at the present time. Stocks are beginning to sell at considerably above book values.

- Changing Industry Structure - Because of growing cash resources, USA utilities are increasingly looking at new business ventures. One example is the increasing attention to mergers. Another is the interest of utilities in non-utility activities. Paradoxically, this is accompanied by considerable interest by others, who are not part of the utility industry, in owning and operating utility facilities such as generating plants, both as cogenerators and as "free market" electricity producers who want to sell their product at the highest possible price. The main driving force for this swapping of roles is the desire to avoid regulation.

- Changing Players - New players are entering the game. The principal ones are the large industrial firms and third-party owners of cogeneration and power plants. These non-utility generators (NUGs) want transmission services and can have an important influence in determining how the transmission system will be used.

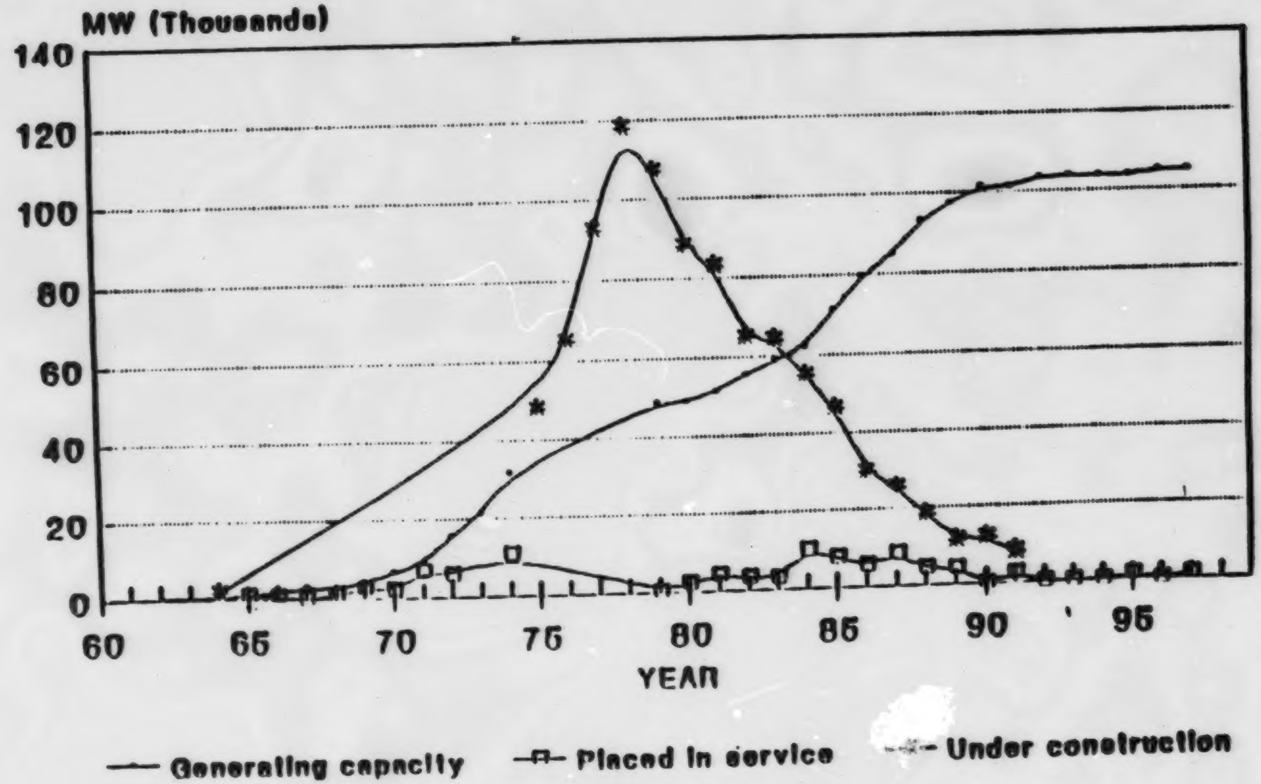
  Another development is the emergence of "power brokers" who own or operate no systems but wish to buy future options on capacity and/or energy, expecting to sell it later at a higher price.

  In addition to these new players, the existing players may be swapping positions. The issues that may cause these changes are:

  - the rights of the owners of the facilities, including their customers and stockholders;
  - the rights of those who have contracted for a use of all or a portion of the facilities;
  - the rates to be charged for wheeling and third-party access;

Figure 2.3

NUCLEAR GENERATING CAPACITY
UNDER CONSTRUCTION AND PLACED IN SERVICE



Data from "Electricity Supply & Demand", NERC, [illegible] -- [illegible] editions, and from "National Power Survey", 1964, 1970.

- the rules and regulations of the various regulatory authorities, both federal and local;
- the efforts of small utilities and municipal utilities to lower their costs of electricity;
- the efforts of large consumers to lower their costs of electricity;
- the efforts of utilities and large cogenerators to sell their surplus generating capacity at the best possible prices;
- the efforts of state regulatory authorities to improve the exchange of low-cost energy between utilities within a state;
- the conflicts between intrastate optimization desired by state commissions and the interstate optimization desired by FERC; and
- the efforts of a new class of brokers to make large individual profits with little investment.

- Changing Rules and Regulations - In the USA, much attention is being given by regulators and legislators, both Federal and state, to the subject of how to control the use of transmission facilities. They are under considerable pressure from outside influences. Some of these outsiders are sincerely concerned with improving the use and operation of the transmission systems so as to increase the savings they make possible. Others are concerned solely about obtaining the rights to use the transmission system for their own gain, regardless of the impact on system reliability, or the costs to the utility customers.

- Changing Functions of Transmission - The USA transmission systems have the delivery of both capacity and energy as their prime functions. Their "capacity role" is to link the individual generating plants and systems together so that the generators available in one area or system can be used to back up the generators in another area in the case of generator outages. Their "energy role" is to permit the dispatch of energy so that the lowest cost energy producer can be used at any time.

  There are two types of transmission facilities: "network" lines and "inter-area tie" lines. The network systems are quite dense, consisting of a large number of lines of decreasing average line length. Generally such networks are capable of delivering power from any generating source in the network at almost all times and can be operated to produce electricity in the most economic manner under normal conditions.

On the other hand, "inter-area" ties link the network systems and generally have limited capacity. Transfers over these ties are limited to the network transfer capability.[11] The inter-area ties were originally installed to reduce generating capacity requirements.[12] They did this by taking advantage of the considerable diversities in generating unit outages and occasional diversities in load characteristics between the network areas. They were economically justified mostly by the reduction in capital investment in generating facilities they produced while maintaining adequate reliability. These inter- area ties provided the additional benefit of allowing the interchange of economy energy.

Over the 1980-1990 time period, with the unintentional increase in generation reserves in the various regions, the relative importance of this capacity role has declined. Coincidentally, fuel cost differentials between regions increased significantly, resulting in increasing economy energy transfers over these lines. Unfortunately, in some cases, the transmission lines that were needed for these growing economy energy transfers were not identical to those originally needed for capacity purposes. The result has been that some portions of the USA transmission networks have become heavily loaded while other portions are relatively under-utilized.

During the next ten years, very little additional base load generation will be added by the utilities in the United States although load growth will continue. Even though some peaking capacity will be added, generation reserves are predicted to continue to decline. As a result, the predominant use of the USA transmission systems will revert back to a capacity-dominated service from an energy-dominated service. Simultaneously, transmission construction is decreasing and reserves are also predicted to shrink.

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[11] "TRANSFER CAPABILITY - A REFERENCE DOCUMENT," National Electric Reliability Council (NERC), October 1980.

[12] Reductions in reserve capacity from the installation of these ties were predicted in the 1964 NATIONAL POWER SURVEY and were achieved in the 1965-1973 period.

- Increasing Transmission System Risks

The pace of transmission construction in the United States has slowed steadily over the last few years. Figure 2.4 shows the ten-year forecasts of transmission additions of USA and Canadian utilities from 1984 through 1989. For each year, the amount of transmission to be built in the USA for the next ten years has been reduced. There has not been as significant a trend in Canada as in the USA.

There are many possible reasons for this trend. One of them may be the decrease in the amount of utility-planned generation over the same period. However, there may be other reasons such as the difficulty of getting lines built due to siting [13] and other environmental requirements, and a reluctance to take the risks involved in building transmission, when after taking these risks, the owner may be forced to make transmission capacity available to competitors for their transactions. Few utilities may be willing to build transmission lines which they may not be allowed to operate and whose use by others may be mandated.

This trend is important to future public policy. If the institutional changes that occur give signals and incentives to utilities not to build additional transmission lines in the future, the ability to make the savings that have been made in the past and to increase these savings in the future will be severely restricted.

- Increasing Transmission System Complexity - The history of the USA transmission systems has shown that the average line length at a given voltage decreases with time as the networks become more complex and continue to include more generating stations and substations in the network. This means that the number of lines and systems affected by a given power transfer will increase in the future, resulting in greater complexity in both system operation and system planning. This increased complexity increases the need for better control of power flow and greater skills and training for the personnel involved in the operating of these networks under both normal and emergency conditions.

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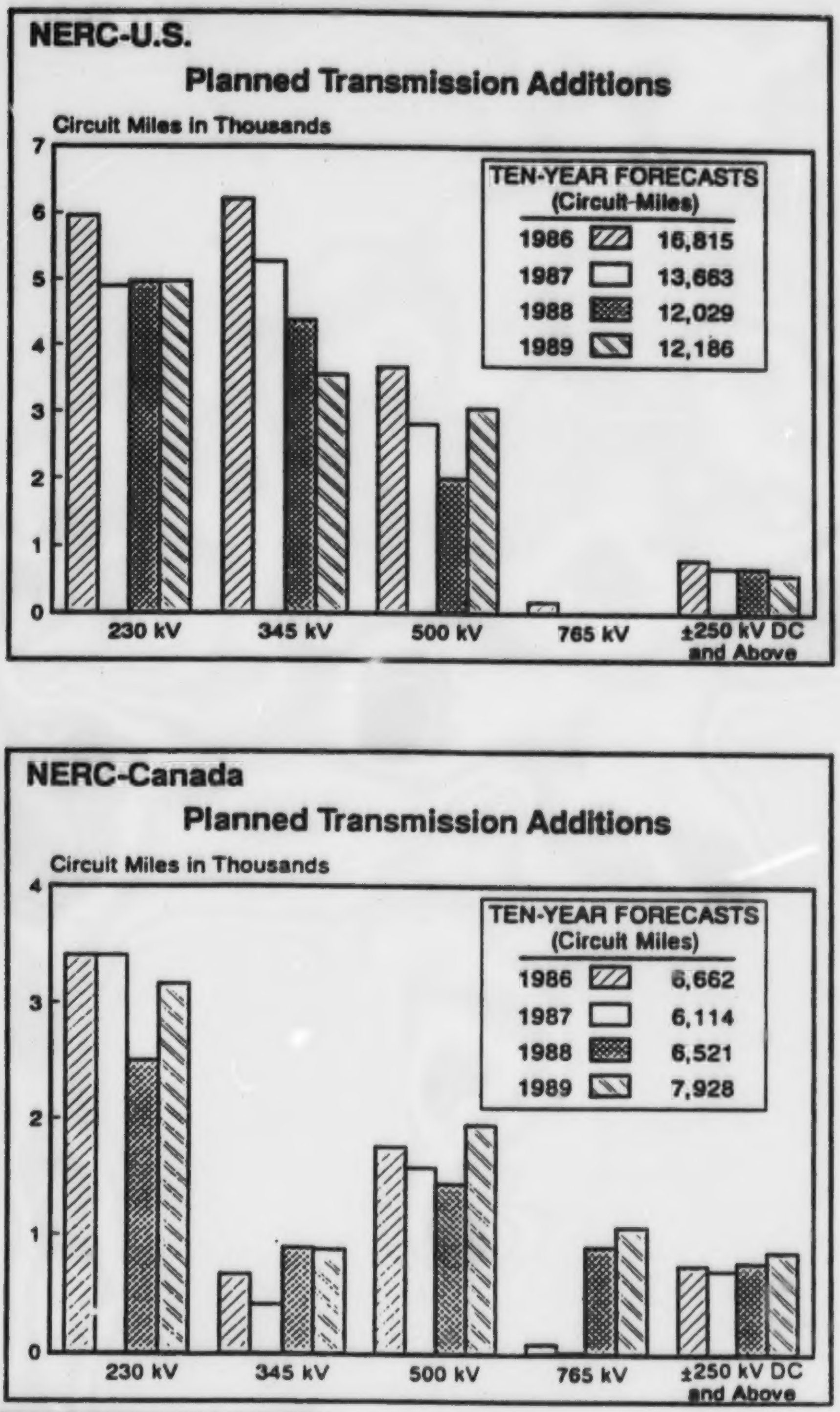
[13] ELECTRIC POWER WHEELING AND DEALING - TECHNOLOGICAL CONSIDERATIONS FOR INCREASING COMPETITION, U.S. Congress, Office of Technology Assessment, U.S. Government Printing Office, Washington, D.C. May 1989.

Figure 2.4 [14]



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[14] Source: 1989 RELIABILITY ASSESSMENT, North American Electric Reliability Council, Princeton, New Jersey, September 1989.

- Changing Transmission Technologies - Power transmission technology is continually changing and evolving. New technology may have a significant role to play in the future. The key role for new transmission technology is to develop ways to improve the utilization of transmission investments. EPRI has a major research program to achieve this called FACTS (Flexible and Controllable Transmission Systems)[15]. We now use solid-state devices to control our reactive supply (e.g., the static var compensators). Other possible technology changes will utilize the advances in computer control and communications technologies in system operations. The future use of solid-state technologies at the power level to control the loading of flow on individual AC circuits is receiving significant research attention. Improved methods for determining transmission use by many parties in a complex network are also receiving considerable attention.[16] [17]

2.1.9 A Technical-Institutional Problem

Like many other utility problems, the question of transmission access and wheeling is a combination problem. It has both institutional and technical components. Among the institutional components are the questions of regulation by states and by the federal government, of ownership, of contractual rights, and of obligations to one's neighbors versus one's own customers. Among the technical components are the need for safe operating procedures and methods, a viable basis for planning the system, and a recognition that new technology may be needed as a result of these changes in transmission uses. *This will require coordinated technical and institutional solutions. Good public policy will provide the economic incentives for the new facilities, and technology and institutional arrangements required by the overall public welfare.*

As the limitations in the USA transmission systems change it from an energy-driven system to a capacity-driven system, the availability of transmission for third party transmission services will decrease. This is a natural result of the need to use transmission to maintain adequate reliability in the various systems.

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[15] "FLEXIBLE AC TRANSMISSION SYSTEM (FACTS)," *EPRI Journal*, Electric Power Research Institute, Palo Alto, California, June 1989.

[16] "TAKING THE MEASURE OF TRANSMISSION FLOWS," *EPRI Journal*, Palo Alto, California, September 1989.

[17] CSA reports for the Electric Power Research Institute: " ON-LINE METHODS FOR DETERMINING TRANSMISSION USE" and "METHODS OF MEASURING TRANSMISSION UTILIZATION " to be published in 1990.

Because of this "swinging pendulum," some key industry leaders caution those who would like to see drastic changes in the way the electric utility industry is organized and operated.[18] If the wrong changes are made, it may not be possible for the electric utility industry to handle the transmission problems in the mid-1990s. They warn that since the function of, and need for transmission change with time, it is essential that industry structure not be changed in such a way that by the time the change is completed the need for the change has disappeared. In other words, the USA has moving targets which require that any changes that are made in the industry structure hit the targets in their future positions.

2.1.10 Need for Additional Transmission

Transmission capacity for wheeling services can be provided in one of two ways:

- build excess transmission capacity to provide any potential generator, both utility and non-utility, with any transmission access it may conceivably require. Some studies have shown the excess required can be very considerable; or
- wait until the locations for the prospective future generation capacity and customers are known, and then try to complete the new transmission facilities needed in time to meet the system condition that arise.

The first alternative will involve a very significant amount of excess transmission capacity, since a great deal more capacity will be needed to meet the uncertainties of future generation and customer locations.[19]

2.1.11 Public Policy Issues

1. Economic Benefits

It is important to determine the effects of transmission access on where and when electric power will be produced. If access does not cause a change in where electricity is produced and when it is produced, no economic benefits will be achieved. Rather, transmission access will merely be a means of reallocating economic benefits.

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[18] "U.S. ELECTRIC SYSTEMS - TECHNOLOGY, HISTORY, AND BACKGROUND," article by W.S. White, Jr., *Public Utilities Fortnightly*, January 5, 1989.

[19] "SHORT RUN EQUILIBRIUM IN A COMPETITIVE ELECTRIC POWER GENERATION INDUSTRY: THE IMPORTANCE OF ABUNDANT CAPACITY," Mark A. Satterthwaite, Proceedings of the Kellog School of Northwestern University, 1987.

2. Environmental Effects

The provision of transmission access to various new potential suppliers of electricity could have an effect on what power plants are built, where they are built, what the sizes of these plants are, and what fuels are burned. These differences can have an important effect on air and water quality.

3. Health Effects

The availability of transmission access could increase the number of transmission lines installed and/or their voltage. Also, different circuit routes could possibly be required because of the different locations of generating capacity. One of the most prominent concerns raised by people living near existing or proposed transmission lines is the potential for adverse health effects from exposure to electric and magnetic fields. Scientists are still investigating whether, and to what extent, these effects are harmful and long lasting, and their possible public health implications. Increased public opposition can be expected if transmission additions proliferate.

4. National Security Effects

Transmission access and changes in generation additions that accompany it may cause significant changes in the types of fuel used for electric generation. Present indicators are that the use of gas and oil could increase significantly with increased competition since the emphasis will be on keeping present generating costs low, not on long-term considerations. Because of the potential long-range shortages of gas, and the need to provide additional oil supplies through imports, it is recognized that transmission access could have an adverse effect on national security.

5. Markets for Canadian Power in the USA

A considerable amount of Canadian power has been transmitted to the USA for sale. [20] Present plans call for increases in these exports (See section 2.4). Changes in the USA procedures in granting transmission access could have a potential effect on the market available for such exports.

2.1.12 Unanswered Questions

Up to the present, the right to use transmission facilities belongs to the owning utilities or those to whom the owners have granted contractual rights. Because of the way AC transmission systems operate, the flow of power cannot be scheduled over specific paths, causing many organizations to use the systems owned by other organizations. The flow of power on transmission systems does not recognize ownership, political, corporate, or geographic boundaries.

There are three basic issues involved in the questions of transmission use and transmission system access and wheeling.

1. Is the optimum use of transmission presently being achieved by the utilities to exchange energy among themselves and lower costs to the consumer?

2. Should increased access to transmission systems be available to third parties (non-owners) to make it possible for them to sell or to obtain capacity or energy (or both) from more remote sources? This question leads to a number of related questions, as follows:[21]

    a. With regard to construction of transmission systems -

        - What increase in transmission facilities will be required to provide the transmission access for open and free competition between potential suppliers of generation?

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[20] "CASE STUDY NUMBER 1 - IMPORTING POWER FROM CANADA TO NEW ENGLAND ," Casazza, Schultz & Associates, Inc.'s report to the Office of Technology Assessment, U.S. Congress, Washington, D.C., November 30, 1988.

[21] "TESTIMONY ON THE RELATIONSHIP OF OUR NATIONAL ENERGY STRATEGY TO OUR NATION'S SECURITY AND DEFENSE," presented by A.J. Schultz and J.A. Casazza at the Department of Energy's Hearing on Energy, Defense, and Security Issues, Washington, D.C., December 1989.

- Who will build, pay for, and operate this transmission?
- Under what policies and regulatory controls?
- What increases will be needed in regulatory manpower?
- What will be the rights (and obligations) of the unregulated sector?
- What will be the impact on the amounts and types of fuels burned?

b. With regard to fuel use -

- How much will decreased vertical coordination in a utility or decreased regional coordination between utilities increase fuel consumption?
- Will the increased development of NUGs using natural gas and oil increase dependence on foreign sources and cause prices for these fuels to rise?
- How will it affect the long-term availability of natural gas for all other national needs?
- What will be the effect on the already seriously "imbalanced" balance of trade?

c. With regard to national security -

- What will the impact be on national security of changes in the electric power industry?
- How will the lack of a single vertically integrated organization and the lack of regional coordination among utilities affect the ability to prevent blackouts and to restore service after storms and other system contingencies which have caused blackouts in the past?
- How will the fuel storage capability being provided in connection with electric generating plants be affected?
- How will this affect the ability to cope with future fuel shortages whether this is caused by the action of foreign governments or national disasters?

- What will be the effect on the ability to withstand and recover from potential sabotage?

3. What legislative and/or regulatory steps are likely at this time? Are there steps that can be taken at this time to reduce regulation and increase competition in the electric power industry? (Some segments of government, the utilities, and industry believe that reduced regulation and more competition will improve transmission utilization and lower overall electric power costs)

The FERC proposed the development of a uniform set of policies for the entire nation. This program has now been abandoned. Key elements in the failure of the FERC efforts were the conflicts between FERC and the various states over regulatory jurisdiction, and the conflicts in concepts among the many interested parties and institutions.

It is now clear that, in the short run, transmission access requests will be decided on a case by case basis. This will lead to an evolutionary trial and error approach for setting policy. This approach could cause long range problems, however. There are many diverse opinions concerning these long range effects. The majority of those with responsibility for managing, planning, and operating the utilities in the USA, whether investor-owned, government-owned, municipally-owned or cooperatively-owned, see major reliability and economic problems with open transmission access in the future [22] [23] [24]. Economic theorists and the legal profession who have no responsibility for executing policy tend to be optimistic about long range results.

2.2 Economic and Institutional Considerations Involved With Wheeling

The impetus underlying wheeling arrangements is savings in the cost of electricity. This is true both of the transactions that have taken place and of the many proposals now under consideration.

Recent USA national averages indicate that of the total investment in electric plant in service only about 12.0% is in transmission plant while 59.3% is in production plant.

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[22] Transmission Policy Paper, LPPC Transmission Access Task Force, August 1989.

[23] "PRICING OF TRANSMISSION SERVICES IN BULK POWER MARKETS," Transmission Issues Monograph, No. 1, Edison Electric Institute, December 1987.

[24] "1989 RELIABILITY ASSESSMENT REPORT," North American Electric Reliability Council, Princeton, New Jersey, September 1988.

Similarly, transmission represents only 2.0% of all Operation and Maintenance Expenses compared with production expenses of 75.5% of the total.[25] Clearly, the very much smaller cost of transmission makes the use of a regionally interconnected transmission system to avoid or to delay investment in generation or to obtain the benefits of lower fuel costs by purchase from more remote sources of considerable interest to utilities and their customers.

If a group of interconnected utilities is in a situation which includes an excess of generating capacity together with unused transmission capacity, the possibility of additional beneficial arrangements is evident. This circumstance arose in the USA during the 1970s. Load growth fell considerably below estimates in response to basic energy price increases stimulated by the actions of OPEC; at the same time, construction costs for new generation tracked the general increased prices resulting from a period of double digit inflation; finally, nuclear plant costs were further impacted by tightened standards and retro-fitting requirements following the untoward events at Three Mile Island #2. Power plants under construction were completed, although sometimes on a delayed schedule; the result was an excess of generation capacity, generally.

This led to a competitive atmosphere as utilities tried to find a market for the excess capacity. Large customers, including municipally-owned utilities and industrials, were desirous of the savings that would result if they were able to change from their traditional suppliers to others that would offer lower prices. New, non-utility generating agencies were formed. The result was an active and rapidly rising interest for transmission service.

The increased attention directed to the subject of wheeling during the recent past in the USA should not be allowed to conceal or obscure the substantial level of transactions that are taking place among utilities and the benefits utilities have and are obtaining for their customers. The graph of Figure 2.5 charts the amount of energy the investor-owned utilities have purchased, interchanged and wheeled from each other. In the 22 years shown, the utilities have doubled the amount of energy they have sold to each other (mostly firm transactions); the amount of energy interchanged has quadrupled (economy transactions, for the most part); and, the energy wheeled has increased by a factor of 6.

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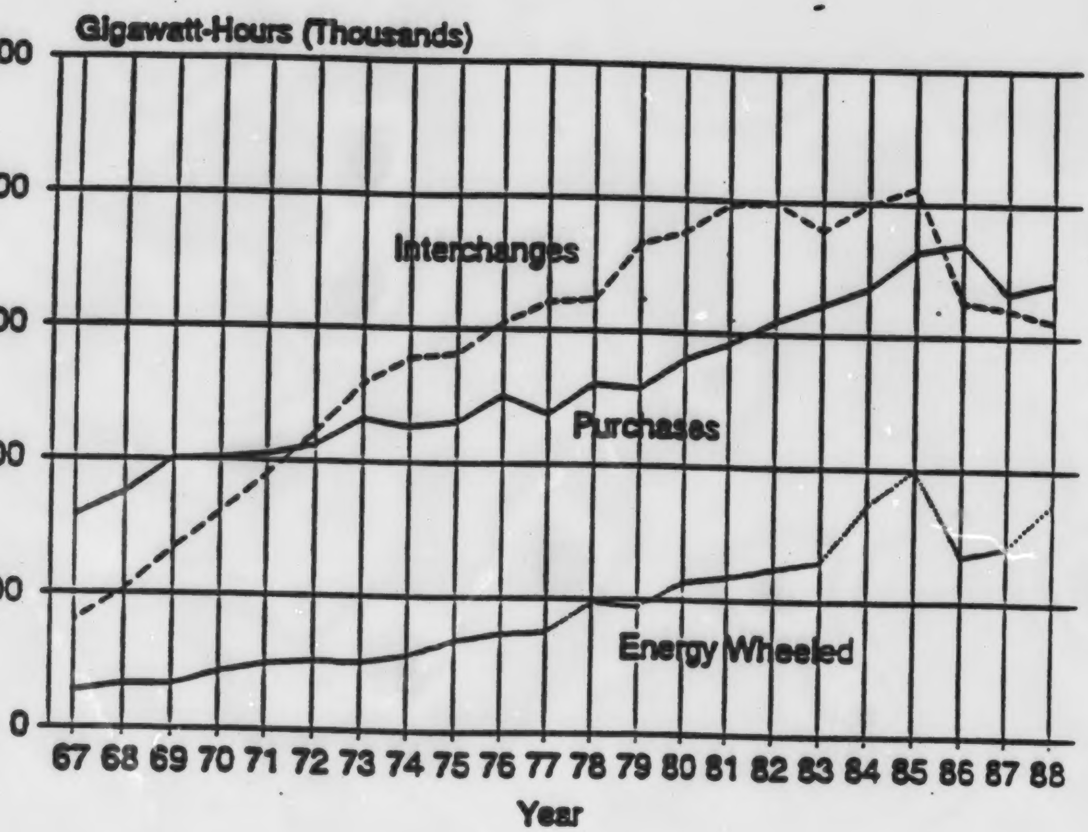
[25] FINANCIAL STATISTICS OF SELECTED ELECTRIC UTILITIES, DOE Energy Information Administration, DOE/EIA-0437(88), Washington, D.C., February 1990.

Figure 2.5 [28]

MAJOR INVESTOR-OWNED UTILITIES

Purchases, Interchange & Wheeling



DOE/EIA 0437 Series

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[28] Source: 1989 RELIABILITY ASSESSMENT, North American Electric Reliability Council, Princeton, New Jersey, September 1989.

It is also appropriate to consider that in the coordination of planning and operations, USA utilities have achieved savings estimated in excess of $15 billion annually.[26] This level of coordination is dependent upon a free and complete interchange of information. If a new deregulated and competitive regime is established as suggested by some of the commentators advocating open access to the transmission systems, the degree to which the utilities will continue to exchange information is a serious question. In short, deregulation of electric utilities may remove the incentive of utilities to coordinate their efforts with a resulting increase in the cost of electricity.

2.2.1 Economic Aspects of Wheeling

As explained earlier, all utilities in the USA and most in Canada are synchronously interconnected with their neighbours to form four large physical systems. A large part of the problems associated with increased wheeling arrangements stems from the diverse ownership of facilities, the lack of coherent policies relating to use of the facilities, and how to measure and allocate the costs and benefits from third party transmission.

Economic theory argues that prices for goods and services should "signal" to customers the consequences to society of decisions to purchase or not to purchase the item being considered.

> "Good decision-making is promoted by customers paying prices close to full marginal costs. The *theoretical* superiority of marginal cost pricing is usually not a matter of dispute any more, even by its current detractors." (Emphasis added.)[27]

Although marginal cost pricing may or may not be *theoretically* superior to other pricing approaches, the problem of pricing wheeling services is a practical problem for which theoretical answers may not be useful.

Economists agree on a fundamental rule for promoting economic efficiency in the electric industry: the marginal cost of generating electricity at any two locations should differ by no more than the marginal cost of transmitting electricity between them.[29] Clearly, if the cost of producing additional energy at one location plus the cost of transmitting that energy is less than the savings resulting from reducing generation by an equal amount in another location, there would be a reduction in total costs.

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[26] GENERATION PLANNING AND TRANSMISSION SYSTEMS, P.J. Palermo, J.A. Casazza, J. Lucas, and F. Branca; CIGRE Paper 37-02, 1988.

[27] SOME ECONOMIC PRINCIPLES FOR PRICING WHEELED POWER, The National Regulatory Research Institute, August 1987, p. 163.

A disparity in the costs of production between two utilities that are not directly interconnected encourages them to request wheeling services from the utility that is interconnected to both. As long as the incremental cost[30] of the transmission service is less than the savings from the power and energy transaction, there would be an improvement in economic efficiency resulting from the arrangements. There are two questions of importance which must be resolved: (1) how to share the net benefits; and, (2) what are the incremental costs?

With respect to the first question, if asked to perform the wheeling for a payment just equal to its incremental cost, the intervening utility will be negative or indifferent to the transaction. Incremental cost, even if there were agreement on its measurement, simply keeps the utility and its customers whole in relation to the circumstances without the wheeling transaction. The investment-related costs of the existing system are sunk costs and ignored in whatever measurements are made of incremental costs. The customers of the wheeling utility are providing the financial support for the existing transmission facilities. With incremental cost pricing, others benefit by using those facilities without payment, while the customers of the wheeling utility, at best, are no worse off than if the transaction never occurred. If the incremental costs are understated (and, as discussed later, the calculation of such costs is complicated with no consensus among advocates as to how to make that calculation), it is the shareholders who are exposed.

The fact is that ownership of transmission facilities is diverse. The owners and managements have responsibilities to the customers they serve and not to customers served by others. Their interest in achieving "economic efficiency" is secondary to realizing low cost for their own customers. This situation will change only when an agency at the national level having the requisite authority imposes policies that modify the current situation.

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[29] ELECTRICITY TRANSMISSION & REALISTIC, THEORY AND POLICY ALTERNATIVES , Federal Energy Regulatory Commission, Washington, D.C., October 1989.

[30] The terms "marginal cost" and "incremental cost" will be used interchangeably, recognizing they are based on the same concept.

The second question concerns the measurement of the incremental costs of the wheeling service. The answer to this question, in turn, depends on the circumstances. If the service is to be provided without any additional investment for new facilities, and without any changes in the operations of the wheeling utility, the incremental costs would include the energy losses associated with the service, the additional costs for regulating generation and for spinning reserves, the added costs for administration and other operating costs, and costs of opportunities foregone, sometimes referred to as congestion costs. Congestion costs occur when the demand for transmission services exceeds the available capacity; additional service can only be provided by curtailing service to another party. Incremental costs for transactions which require no additional facilities are referred to as short run incremental costs.

2.2.2 Losses

The incremental losses are determinable with reasonable accuracy by means of computer model studies under any particular set of conditions. Such studies analyze the system both with and without the wheeling transaction; the difference in system losses between comparable studies is the loss attributable to the wheeling service. Since both load and generation patterns are constantly changing, however, incremental losses during any time period can only be approximated by making a series of analyses reflecting the likely variations in operating conditions over the period for which the service is to be provided. If there is more than one wheeling transaction, a decision must be made as to the order in which the measurements are to be made because electrical losses do not change in proportion to load level changes; instead, losses vary with the square of the load. Are multiple wheeling transactions to be considered in a hierarchy based on the order in which they were entered into, or based on the price that each user is to pay, or are all wheeling arrangements to be considered simultaneously as a unit and share in the responsibility for all losses in excess of those attributable to the utility's native customers?

2.2.3 Spinning Reserves

The operation of the wheeling utility's generation for regulation and spinning reserve might be affected by the wheeling of power through its system. Regulating generation is required by a utility in order to control frequency. To the extent wheeling increases the costs for such generation, those costs are assignable to the transaction. Similarly, system voltages may be affected such that the wheeling utility must operate generation in a different, and more costly, fashion than it would without the wheeling. And, the wheeling arrangements may require changes in the operation of the utility's spinning reserve situation because of its impact on reliability.

2.2.4 Opportunity Costs

When wheeling uses up the wheeler's capacity to trade power with its neighbors, the wheeler may miss some opportunities for economical trades. It may have to pass up the opportunity of purchasing low cost power to displace its own higher cost generation, or it may forego the chance of making a profitable sale. In addition, it may not be able to participate in a diversity exchange with another company with a peak load occurring at another time.

Further, a particular wheeling transaction may use up wheeling capacity, precluding other wheeling arrangements, by other pairs of utilities, that have a higher value. Since these other utilities would be willing to pay more for the wheeling service (in the absence of cap on price), the loss of these potential revenues creates a missed opportunity for the wheeling utility equal in value to the opportunity costs of others.

Opportunity costs may be incurred by a utility that offers firm wheeling, but not with interruptible wheeling, depending on the conditions of interruption in the wheeling contract.

Opportunity costs cannot be known precisely in advance because they depend on what opportunities happen to arise for mutually beneficial wholesale transactions. However, in some cases a wheeler can estimate the value of foregoing certain regularly occurring opportunities.

All of these cost increases are attributable to the wheeling service. They are not all readily and unambiguously determinable.

2.2.5 Pricing of Non-Firm Transmission

Most non-firm power purchases and sales are made on a split savings basis; that is, the price is an average of the seller's decremental costs and the buyer's incremental cost. Each party benefits equally. If the parties to the power transaction are not interconnected directly, wheeling becomes as important to the transaction as is the supply and load. Some three-way split of the savings would appear to fair. The wheeling utility typically receives incremental costs plus a share of the total saving from the transaction. Such saving shares generally range from 15 percent up to 33 percent. This form of pricing of non-firm transmission does not involve the use of embedded costs and therefore avoids disincentives to buy or sell wheeling service of the type associated with embedded-cost pricing.

The second type of rate design for non-firm transmission service is one in which the rate for such service is derived from the rate for firm transmission (plus losses). Typically, this is accomplished by dividing the rate per kW for firm transmission by the number of hours per year, or by some lesser number of hours representing an estimate of the availability of the transmission system to provide non-firm transmission service. A rate derived in this way is likely to exceed the incremental cost of providing the service and may, in some instances, discourage purchasers from using wheeling services to accomplish economically efficient transactions.

The Western Systems Power Pool is in the midst of a continuing experiment in which interutility transactions are determined by marketplace forces. Arrangements which require wheeling are reached through three-party negotiations - seller, buyer and wheeler. (This will be further discussed in Section 2.3 of this chapter).

There have been situations in which utilities have priced transmission services as a percentage of the power purchase price. FERC has instituted a regulation which requires all utilities using a percentage adder to establish a limit to the revenues generated by such an adder. Regulation 35.23[31] provides that any such limit exceeding 1.0 mill per kWh must be cost justified.

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[31] Sometimes referred to as FERC Order #84.

2.2.6 Wheeling Requiring New Facilities

For long-term wheeling service, the addition of new facilities may be required. The measurement of long-term incremental costs is more difficult. In addition to the same operating expense increases discussed above for the short-term transaction, there is also an investment for new facilities to be made. Sometimes the new facilities are directly identifiable with the service to be provided, i.e., a new or an enlargement of an existing point of interconnection, additional metering, etc. Such costs are readily assignable to the service to be provided. In many cases, the facilities that require enlargement to permit the wheeling may be remote from either the selling or purchasing utility, or the required new facility may have a higher capacity than the power level of the transaction. Identifying the incremental cost of the wheeling arrangement becomes controversial - how much of the capacity is due to the utility's load growth and how much to the wheeling transaction. There is another problem if a particular wheeling arrangement requires the addition of a new transmission circuit. The increase in the transfer capability due to the new circuit will have no relation to the amount of power to be wheeled since the capacity of transmission lines comes in discrete sizes. The increase in transfer capability can be determined, as can be the installed cost. An investment per kilowatt of transfer capability can, therefore, be calculated. This unit cost could be used as an incremental demand rate or price and applied to the amount of power involved in the wheeling arrangement. If the power to be wheeled, however, is less than the increase in transfer capability, the transaction will not generate sufficient revenues to support the cost of the new facilities; the wheeling utilities customers or shareholders will have to support the line initially, until there is load growth that will generate sufficient revenues. Thus, the wheeling transaction has an additional cost - the cost of supporting an investment made in advance of the time it would otherwise be needed.

Some recently filed transmission service tariffs require the wheeling customer to support the entire investment in required new facilities. If there is a mismatch between the power to be wheeled and the increased transfer capability resulting from new facilities, these tariffs provide no rights to the wheeling customers for the excess capacity for which they are to pay. If there is such capacity or if the transmission facility's service life exceeds the duration of the wheeling arrangement, the wheeling utility's own customers benefit.

Some U.S. utilities have filed "open access" types of transmission tariffs. These, for the most part, simply commit the utility to offer to provide wheeling service to any qualifying entity. The price for the service, however, is to be determined after the impact of the service on the wheeling utility is measured. Engineering studies will be made to analyze the power flows, voltage conditions and system stability with the wheeled power superimposed on the normal situation in order to determine whether or not system additions are required. The applicant for wheeling service may be required to pay for the studies.

2.2.7 Shifting of Benefits

Although wheeling would allow sellers and purchasers of power to reach a more extensive market and improve the economic efficiency of the power supply universe, the implication is that Pareto efficiency is meant; the benefits of whatever arrangements being discussed should exceed the incremental costs to society, and not only just the costs of the parties involved. If, because of wheeling, one power purchaser is enabled to substitute for another, that purchaser is benefitted but at the expense of the one displaced. Whether or not wheeling should be extended to such transactions is a policy matter yet to be resolved.

In any situation where changes in the rights to use the system do not result in a change in the dispatch of the system, economic benefits are only being re-allocated, not created.

FERC dealt with a similar problem in the case of the Pacific Power & Light Co./Utah Power & Light Company merger. The Administrative Law Judge (ALJ) that heard the case concluded that the benefits claimed for the merger were speculative, or could be achieved without the merger, or that they were gained by the parties at the expense of others. Accordingly, the ALJ recommended against the merger. The Commission appears not to have disagreed with the judge but approved the arrangement after imposing certain conditions on the operations of the merged companies.[32] The FERC's conditions were particularly directed to the use of the transmission system of the merged companies. FERC has stated that these transmission arrangements are applicable to this particular case and not a precedent for other situations.

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[32] RE UTAH POWER AND LIGHT COMPANY ET AL. FERC Docket No. EC88-2-000; Opinion No. 318; 96 PUR4th 325.

Marginal Costs and Revenue Requirements

Among the many publications on the subject of wheeling, one of particular interest is the August 1987 report of the National Regulatory Research Institute on the subject, "Some Economic Principles For Pricing Wheeled Power". The report is intended to be a contribution to consideration of an answer to the question, "What does economic theory say is the best way to price wheeled power?" The report states, "..there is a test for whether wheeling rates encourage good decision-making, which always applies. We call this test the equalization of marginal costs across the grid. Under any set of laws, regulations, or institutional arrangements, the best wheeling prices are those that reduce the difference in electricity costs between any pair of electricity producers to the incremental [sic] cost of moving power between them, or less."

While the report advocates incremental cost pricing for wheeling services, it does recognize certain difficulties of that approach. The difficulties are not those associated with the determination of marginal costs, about which the report provides little guidance. The problem cited is that short-run marginal costs produce revenues that are less than revenue requirements and long-run marginal costs generate revenues in excess of revenue requirements. Consequently, the report concludes that:

> "The only policy choices then are either to have a policy of marginal cost pricing for wheeling with no revenue requirement or to have a revenue requirement with wheeling prices that come as close as possible to achieving the goal of good decision making."

The reconciliation between marginal cost prices and revenue requirements suggested by the latter choice results in a further complication. The most common proposal is the use of so-called Ramsey pricing in which marginal costs are weighted by the inverse price elasticity of the customer's demand for the service to allocate the total revenue requirement. The elasticity of demand for transmission services is unknown at this time.

2.2.8 Transmission Policy Proposals

A number of organizations and groups have published proposals intended to serve as the basis for the establishment of national policies relating to transmission. (These are identified in Table 2.1. Descriptions of some of these proposals are given in Appendix 2-

Table 2.1

ORGANIZATIONS IN THE USA STUDYING WHEELING AND TRANSMISSION ACCESS

- KEYSTONE GROUP
- NATIONAL GOVERNORS ASSOCIATION
- OFFICE OF TECHNOLOGY ASSESSMENT
- DOE OFFICE OF POLICY ANALYSIS
- NARUC via NRRI
- ELECTRIC POWER RESEARCH INSTITUTE (EPRI)
- ENERGY INFORMATION ADMINISTRATION (EIA)
- FERC
- ELECTRIC CONSUMERS RESOURCE COUNCIL (ELCON)
- TRANSMISSION ACCESS POLICY STUDY (TAPS)
  - Public Power Utilities
- EDISON ELECTRIC INSTITUTE (EEI)
  - Investor Owned Utilities
- NORTH AMERICAN ELECTRIC RELIABILITY COUNCIL (NERC)
- LARGE PUBLIC POWER COUNCIL (LPPC)

C of the Casazza & Schultz Associates Inc. report to the National Energy Board). Generally, the proposals from groups that own transmission have certain broad similarities that allow them to be distinguished from the proposals of the groups representing agencies that wish access to the transmission systems.

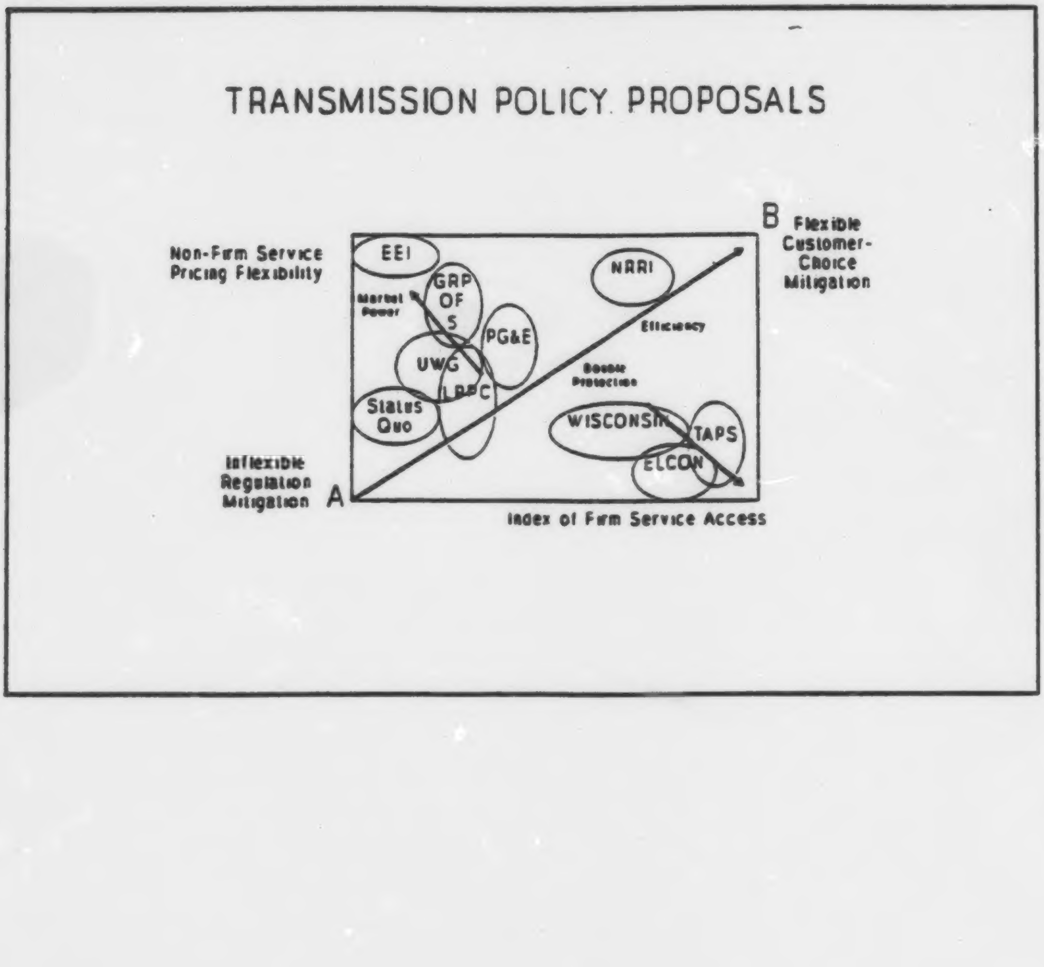
There are approaches of two other entities - NRRI and the British grid - that appear to exist somewhere between these.

FERC formed a Transmission Task Force to study transmission policy issues in the Fall of 1988. The Task Force's report Electricity Transmission: Realities, Theory and Policy Alternatives was published in October 1989. The Task Force analyzed the dozen approaches referred to above and was able qualitatively to relate them in a framework of two dimensions. The vertical axis represents the degree of pricing flexibility for non-firm transmission service, under conditions of voluntary access. The horizontal axis represents the degree of accessibility to long-term, firm transmission services, with the condition that prices be based on costs. The results of this comparison are reproduced in Figure 2.6.

As shown in Figure 2.6, the groupings of transmission owners, in general, suggest approaches more "efficient" for non-firm transmission and those of the groups desiring increased access are more "efficient" with relation to firm transmission access. The two approaches which are "efficient" in both dimensions, that of NRRI and the British grid, are based on different structural models than are the others.

One further comparison of approaches to transmission pricing and access of the FERC Task Force is of interest. The proposals are grouped into three alternatives: a "Contract" model reflecting the proposals of the transmission owner groups in which transmission services would be offered by contract to other parties with the owners adding facilities as required; a "Joint Planning/Joint Ownership" model (Planning model in which all parties would participate in the planning and ownership of new transmission); and the "British" model reflecting the privatization initiative of the British power systems. These three conceptual models for transmission alternatives are compared for 13 areas of concern in Table 2.2.

Figure 2.6 [33]



TRANSMISSION POLICY PROPOSALS
Non-Firm Service Pricing Flexibility
B
Flexible Customer-Choice Mitigation
EEI
GRP OF S
Market Power
NRRI
PG&E
Efficiency
UWG
LPPC
Double Protection
Status Quo
WISCONSIN
TAPS
ELCON
Inflexible Regulation Mitigation
A
Index of Firm Service Access

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[33] The Transmission Task Force's Report to the Commission, ELECTRICITY TRANSMISSION: REALITIES, THEORY, AND POLICY ALTERNATIVES, The Federal Energy Regulatory Commission, Washington, D.C., 1989, p. 142.

Table 2.2

MAJOR POLICY DIMENSIONS OF THREE ALTERNATIVE TRANSMISSION PROPOSALS

ISSUE/CONCERN	CONTRACT	PLANNING	BRITISH
1. Reliability	Owner's Duty	Owner's Duty	Owners Duty
2. Stranded Investment/ Inefficient Wheeling	Governed by Contract	Governed by Joint Plan	Governed by Central Plan
3. Environmental/ Siting Issues	Duty of State PUC	Duty of State PUC	Duty of Transco
4. Structural Change	Small	Major	Radical
5. Quality of Service	Point to point	System Wide	System Wide
6. Price Discrimination	Probably (Vintage Pricing)	No	No
7. Who Bears Future Price Risk?	Depends On the Design	Shared Through Joint Planning	Shared Through Joint Planning
8. Who Has Priority?	Core Customers	No One	No One
9. Method of Enforcement	Contracts	Joint Planning	Joint Planning
10. Parallel Flows	Contract Path	Real Flows in Region	Real Flows
11. Retail Bypass	Not Allowed	Not Allowed	Not Allowed
12. Accommodates IPPs	Yes	Yes	Yes
13. Requires Legislation	No	Yes, probably	Yes

Source: The Transmission Task Forces Report to the Commission Electricity Transmission: Realistic, Theory and Policy Alternatives FERC, 1989, p. 148.

The FERC Task Force report, "...in keeping with the terms under which it was commissioned, does not endorse any particular future as the appropriate one for this industry or any particular regulatory strategy for the FERC." The report does make some "observations" and "points" which appear to reflect the authors' own views of the desirable future of the electricity industry, notably the establishment of a competitive environment open to all entrants, utility and non-utility, for the production of power and the requirements for transmission policies to encourage this situation. These views are not supported by all interested parties; nothing approaching a consensus exists yet in the USA.

2.2.9 Non-Technical Impediments to Wheeling

The most comprehensive consideration of this subject is the September 1987 NRRI report, Non- Technical Impediments to Power Transfers . A listing of the non-technical impediments to wheeling discussed in the NRRI report is given in Table 2.3. A very large part of the identified impediments are attributable to aspects of regulation at the state and federal levels.

2.2.10 Regulatory Uncertainties

Part of the wheeling problem in the USA results from the undefined boundaries between Federal and State regulation. Federal jurisdiction extends to the transmission of electric energy in interstate commerce and the sale of such energy at wholesale in interstate commerce. The Federal Power Act, very specifically, states:

> ...The Commission [FERC] shall have jurisdiction over all facilities for such transmission or sale of electric energy, but shall not have jurisdiction, [certain exceptions omitted], over facilities used for the generation of electric energy or over facilities used in local distribution or only for the transmission of electric energy consumed wholly by the transmitter.[35]

The FERC's authority to set rates in interstate commerce has been held to be preemptive over any conflicting decisions by state regulators in a line of court decisions consistently

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[35] FEDERAL POWER ACT, U.S. Government Printing Office, Part II, Section 201 (b)(1).

Table 2.3[36]

NON-TECHNICAL IMPEDIMENTS TO POWER TRANSFERS
(Asterisks denote the more important impediments)

I
INSTITUTIONAL IMPEDIMENTS

Regulatory Institutions
* Federal - State dichotomy
* Franchises
Rate-of-Return Regulation

Organizational Institutions
* Diversity of Ownership
* Holding Companies & Power Pools
* Avoided Costs for Cogeneration
Changes in Fuel Use Restrictions
* Mergers and Buy-Outs

Opposition to New Operational Institutions
Competition and Bypass

* Mandatory Wheeling
National Grid
Spot Market

II
LEGAL IMPEDIMENTS

Limited FERC authority
* Over wheeling
Over interconnections

State Authority Over Wheeling
Limitations
* Uncertainty

Franchise Laws
Monopoly Service Areas
Cogeneration Sales Restrictions

Antitrust Laws
Standards of Proof
State Action Exemption

Laws Impeding Construction
* Siting
Certification
Eminent Domain

Loop Flows
Neighbours' Right

III

REGULATORY IMPEDIMENTS

FERC Regulations
Filing Requirements
* Embedded Cost Pricing
Rolled-In Costing
* Voluntary Agreement Uncertainty
Multisystem Transmission Rates
Fixed Equity Returns
* Termination of Contracts

State and Local Regulations
* Treatment of Transmission Revenues
* Siting and Licensing New Lines

Federal - State Jurisdictional Uncertainty
Overlapping Authorities
Weak Regulatory Authorities

IV

ECONOMIC IMPEDIMENTS

Uncertainty About Wheeling Costs
Costs by Type of Customer
Costs by Type of Wheeling
Operating, Network & Generation
Capital Costs

Uncertainty About Wheeling Rates
Embedded versus Marginal Costs
* Marginal Cost Measurement
* Rate Structure Determination
* Revenue Reconciliation

Uncertainty About Profit and Loss
* Buyer/Seller versus Wheeler Profit
* Losses for Bypassed Generating Plant
Lost Trading Opportunities

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[36] NON-TECHNICAL IMPEDIMENTS TO POWER TRANSFER , CSA report to the National Regulatory Rate Institute, September 1987.

upholding the so-called Narragansett doctrine, the first of such decisions. Consistent with those decisions, and recognizing the degree to which all USA utilities are interconnected without regard to state boundaries[36], essentially every wheeling tariff would be subject to FERC jurisdiction.

Even though FERC has jurisdiction over wheeling tariffs once entered into, its authority to order wheeling is quite limited. If a utility voluntarily enters into a wheeling arrangement, FERC has jurisdiction over the terms and conditions of service, including rates. If a utility declines to enter into a wheeling arrangement, FERC can act only under certain conditions:

Federal Power Act - Section 210

FERC can order interconnections by finding it to be in the public interest if it:

a. encourages overall conservation of energy or capital

b. optimizes the efficiency of use of facilities and resources

c. improves the reliability of the electric system and, the requirements of Section 212 are met.

Federal Power Act - Section 211

FERC can order transmission services by finding that:

a. a significant amount of energy is conserved

b. efficient use of facilities and resources is significantly promoted

c. reliability of the electric utility system is improved and, the requirements of Section 212 are met, present competitive relationships are reasonably preserved, and transmission to ultimate consumers is not a result.

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[36] In the Colton decision, the US Supreme Court upheld the FPC's determination that interstate power flows could be established without having to trace power from the sources to points of consumption. FPC V. SOUTHERN CALIFORNIA EDISON CO., 376 US 205 (1964).

Federal Power Act - Section 212

A FERC order under sections 210 and 211:

a. May not result in a likely ascertainable uncompensated economic loss

b. May not create an undue burden

c. May not impair the reliability of the electric utility affected by the order

d. May not impair the ability of the electric utility affected by the order to provide adequate service to its customers

These elements of the Federal Power Act were added as part of the national energy legislation of 1978. As yet, there have been no significant decisions under these sections.

State commissions are concerned with electricity supply and delivery within their own states. Competition by the states to achieve the lowest electricity costs for their own constituents, or to avoid the environmental effects of generation or transmission facilities in their state could lead to a "balkanized" approach that might be effective for each jurisdiction but not necessarily optimized for the region. For example, several years ago, certain New England and Appalachian region states proposed additional transmission lines between their areas so that coal-based electricity could be delivered to the high cost areas of the northeast. New York and Pennsylvania, through which the lines would pass, saw no benefits to themselves; without their participation, the proposal was discontinued.[37]

A recent order by the Wisconsin Public Service Commission includes unique language with respect to state-wide interconnected transmission of the utilities subject to its jurisdiction.[38] Under the heading Transmission System Use and Cost Sharing, the PSC stated:

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[37] "PROBLEMS OF STATE REGULATION OF UTILITIES PARTICIPATING IN MULTI-STATE INTERCONNECTIONS", Martin E. Gordon and Allan J. Schultz, Proceedings of the Fifth Naruc Biennial Regulatory Information Conference, September 1986.

[38] RE ADVANCE PLANS FOR CONSTRUCTION OF FACILITIES, 05-EP-5, Wisconsin Public Service Commission, April 6, 1989.

> "The transmission system is a monopoly affected with the public interest and it is to be used for the general public good. The transmission system is made possible by the state's grant of its sovereign power of eminent domain, which is a recognition of the public's interest in the universal provision of reliable electric service. The basis of a utility's right to own and/or use the transmission system of the state is the utility's obligation to serve load within its service territory. The avoidance of the duplication of facilities minimizes costs and environmental impacts. Equitable allocation of the costs and use (benefits) of the non-duplicative transmission system among all utilities and cooperatives constitutes use of the system for the general public good".

The PSC ordered all major utilities of the state (of which there are seven) to enter into transmission system use and cost sharing agreements with each of the others with which they share a border, and with each small investor-owned and municipal utility with which they share a border which choose to enter into an agreement. The agreements were to embody 20 principles adopted by the PSC. The major investor-owned utilities also were ordered to file wheeling rates with FERC. Both of these orders were to be accomplished within a year of the order.

2.2.11 Pricing for Transmission Services

There are very few systems in the USA that would be unwilling to provide transmissions services in the future if they were paid enough for the service and they were able to retain operating control of their systems. Some gas systems in the USA prefer to wheel to their large industrial customers because, with their current rates, their earnings are greater than from direct sales. From the economic and financial viewpoint the key factor is what rates will be allowed? How will transmission services be bought and sold?

Commissioner C.M. Naeve of FERC[39] has suggested the following fair pricing guidelines for transmission service.

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[39] "TOMORROW'S ELECTRIC UTILITIES: WHICH WAY TO SERVE RELIABILITY AND PRICE STABILITY? ," by C.M. Naeve, Commissioner of the Federal Energy Regulatory Commission, presented at the NARUC 98th Convention and Regulatory Symposium, Phoenix, Arizona, November 18, 1986.

"First, there should be sufficient pricing flexibility for utilities to respond to changing cost conditions, insasmuch as transmission costs vary for each particular trade.

Second, prices should allow for the recovery of all economic costs of transmission. These might include, for example, increases in base load fuel costs resulting from changes in transmission patterns, or the capital costs of new transmission facilities that may be needed to perform the service. Transmission system users must see price signals based on real economic costs, or transmission resources will not be used efficiently. Moreover, if transmission providers cannot recover all of their costs, access is likely to be constrained.

Thirdly, transmission prices should provide some incentive for utilities to install new facilities. As indicated earlier, I think this is where the FERC can best enhance transmission access.

Fourth, when there are capacity shortages, prices should allocate any transmission capacity not needed for native load service to the highest valued uses. Limited capacity should be used for those trades that produce the greatest net cost savings. This results in the best use of existing facilities. In such shortage situations, I believe that price - rather than regulatory intervention - is the best allocation mechanism.

And finally, transmission pricing policies should not allow the exercise of monopoly power. In many parts of the country, transmission is still a natural monopoly. Unrestrained monopoly pricing in transmission could retard the development of efficient power markets. Prices must therefore be kept below monopoly levels while still allowing the flexibility and incentives needed to accomplish the first four pricing objectives."

In brief, Commissioner Naeve and many others[40] have suggested that utilities providing transmission service should be allowed to:

1. Earn a fair return on their investment.
2. Be fully compensated for any saving in their own operation which they forego in providing transmission service.

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[40] "UNDERSTANDING THE TRANSMISSION ACCESS AND WHEELING PROBLEM," J.A. Casazza, *Public Utilities Fortnightly*, October 31, 1985.

3. Receive a fair share of the economic benefits or saving which they create by providing transmission.
4. Have full authority and responsibility for the operations of their systems.

2.3 Wheeling Arrangements in Effect in the USA

2.3.1 Types of Wheeling Service

Wheeling services with many different conditions and arrangements are in effect. They can, however, be classified into two major types of service:

a. Firm Service

Firm Service, in almost all cases, refers to the firmness of the commitment to wheel after the wheeling utility has agreed to provide the service, and a rate schedule or service agreement has been signed, stating the amount of power to be wheeled. Firm service generally means that once the wheeling utility has made a commitment to wheel, it will not interrupt the service except under certain conditions. Those conditions generally are:

1. Interruption due to factors reasonably beyond the control of the utility and not attributable to its neglect, such as lightning damage, a flood, or a labour strike. This condition is often referred to as force majeure.

2. Danger to the reliability and sound operation of the utility's electric system in accordance with good utility practice.

3. Maintenance, repairs, replacements, installation of equipment, or investigation and inspection.

4. Failure of the wheeling customer to comply with terms and conditions of the tariff or service agreement, such as nonpayment of bills.

Some utilities further subdivide their firm service into short-term and long-term service. For example, short-term service may be for less than a year and long-term service for a year or more.

Generally, it appears that once a commitment is made to provide firm wheeling service to a particular customer (usually for a specified amount of power and time period), inadequate transmission capacity is not a condition for interrupting service, unless, of course, the inadequate transmission is due to emergency factors described previously. This implies a commitment to install additional equipment, if necessary, to maintain firm service during the period covered in a long-term commitment to wheel.

For the most part, firm wheeling is associated with power purchased under long-term contracts, unit contracts and entitlements in jointly-owned units. The terms of service under these contracts are generally for extended periods, often 20 years and, in some instances, for as long as 40 years. Service is provided continuously, even in emergency situations, so long as service to the wheeling utility's own customers is not impaired. In some arrangements, this service is provided with the same priority as for the utility's native customers.

Priority

A very important characteristic of a transmission service is the priority of the particular transaction should curtailment be necessary. In general, firm transactions will have a much higher priority than non-firm transmissions. However, a further ordering of priorities is required within firm transmission service. If a utility provides firm transmission service to several other utilities, it might allocate curtailments evenly among all those using the firm service at a single time. Alternatively, it could give the highest priority to utilities paying a higher rate than others. A third approach might be to assign priority on the basis of when a contract is initiated, with the oldest transactions receiving the highest priority.

Priority of transmission service is a particularly important and sensitive issue among utilities subject to loop flow curtailments.

b. Interruptible Service

Interruptible (or non-firm) service means that the wheeling service can be curtailed or interrupted for reasons other than those specified for firm service. Two different types of interruptible service are represented in the wheeling arrangements reviewed. One type identifies the condition for interruption (in addition to those specified for firm service).

This service may be referred to as conditionally interruptible service. In most instances, the specified condition is the need for transmission capacity for the wheeling utility's own sales of power. The second and more common type of interruptible service specifies no predetermined conditions for interruption. Wheeling can be interrupted any time at the sole discretion of the wheeling utility. This type of service may be referred to as unconditionally interruptible service.

The term "non-firm energy" (otherwise referred to as "interruptible energy") is used in a generic sense; i.e., many contracts do not provide a detailed description of the non-firm energy to be wheeled. Generally, the wheeling service is for power wheeled only on a daily or weekly basis, which has been purchased on a "when and as available" basis.

Non-firm wheeling arrangements tend to have shorter terms than firm arrangements and tend to be less precise with regard to explicit delineation of operating procedures. Non-firm wheeling arrangements are often reflected in one- or two-page letter-type contracts. Non-firm arrangements can be further differentiated on the basis of whether the contract specifically guarantees services for emergency situations. Some non-firm arrangements provide for such non-firm wheeling in an emergency. Some provide for emergency wheeling of entitlements when firm service is interrupted due to unscheduled outage of transmission facilities of other systems. Other emergency arrangements provide for the delivery of emergency energy and other types of unspecified non-firm energy in the event of an unscheduled outage of a generating source either owned or purchased by the wheeling customer.

2.3.2 Billing Methods

A review of billing arrangements in use for wheeling services reveals a wide variety of approaches in general principles and in details. This variety will be examined in three aspects:

- The conceptual basis: this is the general approach taken, and represents questions of basic philosophy. Examples include the contract path, postage-stamp, boundary flow, line-by-line, transaction value, and phantom line methods.

- The billing determinant: this the actual type of quantity for which billing is applied, such as energy, capacity, money saved, or megawatt-miles (the product of capacity wheeled and the distance over which the wheeling takes place).

- The pricing basis: this is the choice of factors that determine the unit prices to which the billing determinant are applied. Examples of these are: depreciated costs, original costs, short-term marginal costs, and long-term marginal costs.

2.3.2.1 Conceptual Basis

The various conceptual bases used in billing for wheeling services represent the basic approach used in each case.

a. The Contract Path Method

The Contract Path method develops a wheeling cost using a specified electrically continuous path from a generator (or a point of receipt if more than one utility is involved) to a point of delivery (i.e., the buyer or an adjacent utility system). The per unit cost developed is the cost that must be collected by the wheeling utility as compensation for use of its investment in the specified path. Since the cost is developed only for the specified path, this method does not attempt to recover costs for investments that may provide "firming" support for the wheeling but which are not on that path. In addition, as the method is based generally on embedded costs, it does not recover the costs for any further investments until they are placed in service. This method consists of the following major steps:

- Selecting the wheeling contract path;
- Determining the transmission capability of the selected path;
- Ascertaining the cost components of the selected facilities; and
- Calculating the fixed charge rate.

Selected Path

The contract path for the wheeling utility is a specified electrically continuous transmission path between the points of power receipt and delivery. Typically, the points identified are the wheeling utility's most direct and electrically "closest" points of interconnection between the power receipt and delivery points. Transmission system facilities used in the method, however, may include those lines that would experience a significant through-flow.

In general, only bulk power transmission facilities (i.e., transmission lines and substation facilities) are considered to be used for long distance wheeling transactions. However, when relatively short distances or local wheeling transactions are involved (e.g., for generators connected at lower voltage levels and involving power wheeled to a nearby service area), subtransmission facilities may be included. It also bears noting that utilities vary in the voltage ranges they consider to be subtransmission.

Transmission Capability

Transmission system capability for the selected path may be based on load flow simulations in order to avoid assigning more capacity to a path than system limitations permit. Most often, however, it is based on the ratings of the path components themselves, generally adjusted by some factor, such as 80%, to provide for system limitations. If a single transmission line is selected as the contract path, its thermal line rating, expressed in megawatts (MW), is generally used as its transmission capability, often modified by some constant factor. When multiple transmission lines are selected, interfaces can be specified for the purpose of determining the transmission capability. In such cases, either the thermal transfer limit or the stability/voltage limit of the interface(s), whichever is lower, is used as the transmission capability.

Cost Components

Being an embedded cost approach, the contract path method requires that a wheeling utility's historic costs for the most current available year be collected and tabulated. These costs include annual transmission-related operating expenses and both the book cost (i.e., original cost) and depreciation for all transmission facilities, including the contract path transmission facilities.

The annual fixed charge rate for the system is calculated from the cost of owning and operating all transmission facilities and their book cost. See section 2.3.2.3.

The Cost Of Wheeling Calculation

The contract path per unit cost of wheeling is computed by combining the above described elements algebraically. The book cost of the contract path facilities is multiplied by the annual fixed charge rate (AFCR) to derive an annual cost for use of the associated facilities. A per-unit wheeling cost is subsequently obtained by dividing the annual cost in dollars by the appropriate transmission capability of the path.

$$\underset{(\$/\text{MW})}{\text{Annual Per Unit Cost}} = \frac{\text{AFCR (\%)} \times \text{Cost of Contract Path (\$)}}{\text{Path Transmission Capacity (MW)}}$$

Summary of Attributes

The Contract Path method has often been employed in practice. While allocation of costs is always a problem, this method utilizes a utility's historic costs, which are known and verifiable. The Contract Path approach, however, limits consideration to the cost of facilities along the contract path and disregards the fact that power may flow through other transmission lines, including those of other systems. As such, this method does not expressly consider investments required to support a wheeling transaction but which are not on the contract path. It also does not reflect the cost of new investments until they are included in the wheeling utility's book costs.

b. The Postage Stamp Method

The Postage Stamp method differs from the Contract Path method in that it considers system-wide transmission costs rather than the costs of specifically selected facilities. This method is often referred to as the Postage-Stamp method because it results in the same wheeling cost irrespective of distance or location. Following this method, a wheeling utility's total annual transmission, and possibly subtransmission, system costs are considered in developing the wheeling charge.

Summary of the procedure:

a. The wheeling utility's book costs are collected and tabulated for use in a cost of service study.

b. The costs are functionalized (production, transmission, distribution, etc.)

c. The AFCR is calculated and is comprised of the rate of return, depreciation, taxes and expenses.

d. The sum of the transmission-related annual costs is the annual revenue requirement. The per-unit wheeling rate is the revenue requirement divided by the selected demand basis (e.g., peak demand, peak demand plus firm wheeling, or designated system capacity).

Summary of Attributes

The Postage Stamp method shares some of the features of the Contract Path method in that it has often been employed in practice and utilizes a utility's historic costs, which are known and verifiable. As a "rolled-in" method, it does not rely on an assumed power flow path, but it also does not recognize that power may flow through other utilities' systems. As such, this method does not expressly consider investments required to support a wheeling transaction by utilities that are not a party to the wheeling transaction. It also does not directly reflect the cost of new investments until they are entered into the wheeling utility's rate base. The costs for new investments are shared by all customers independently of their incurrence.

c. *The Boundary Flow and Line-By-Line Methods*

Utilities are affected by wheeling transactions through changes in power flows on their systems (i.e., wheeling may cause loadings on certain transmission lines to decrease or increase). The Boundary Flow and the Line-By-Line methods seek to identify incremental power flows resulting from specific firm power wheeling transactions and to assign wheeling costs in proportion to the change in flow. The changes between the transmission system power flows with and without a wheeling transaction are determined by load flow studies simulating transmission system conditions. Wheeling costs are calculated by multiplying the MW flow changes for each utility by its unit transmission cost-of-service (in terms of \$/MW or \$/MW-mile).

The Boundary Flow and Line-By-Line methods are distinct costing approaches. A Boundary Flow analysis examines the impact of a wheeling transaction only on the transmission lines that tie one utility to another; this indicates the amount of the transaction that flows through each affected utility. The Line-By-Line method examines the impact of the wheeling transaction on all transmission lines in a utility's transmission system, and therefore takes into account the specific lines on which the wheeled power flows.

Boundary Flow Method

Under the Boundary Flow method, there are two ways to calculate the changes in power line loadings: the net interchange basis and the line basis. The net interchange basis consists of computing the change in power flow for a utility by summing the absolute values of the net interchanges with each neighbouring utility and dividing by two. This procedure eliminates the impact of circular flows, which may enter a neighbouring utility at one point and leave it at another. This method of summarization incorporates the effect of circular flows.

Line-By-Line Method

A number of approaches may be taken to determine wheeling costs using a Line-By-Line method. All utilize the megawatt-miles of the wheeling utility's transmission lines as a parameter.

One approach is to subtract negative MW-mile changes (i.e., lines whose loadings decrease due to the wheeling) from lines with positive MW-mile changes (i.e., lines whose loadings increase due to the transaction). This approach credits a utility for transactions that enhance transmission capacity. Negative MW-mile changes can result in lower wheeling charges by offsetting some positive changes.

A second approach uses the absolute value of each MW-mile change (the absolute value of positive and negative MW-mile changes are added). This approach compensates utilities for any significant use of affected lines, even uses that actually decrease the net loadings.

A third method uses only positive MW-mile changes and ignores negative MW-mile changes.

All Line-By-Line approaches calculate a $/MW-mile rate for the wheeling utility by dividing the total net embedded transmission cost of service, by the total system MW-miles. The system MW-miles value is calculated by summing the MW-miles for every line in the wheeling utility's system. The calculation can be based upon each line's actual peak loading determined by computer analysis or its design rating.

Calculation of Transmission Revenue Requirement

The Boundary Flow and Line-By-Line analyses identify affected utilities and the extent to which a wheeling transaction affects each utility. Once the MW transfer amount is calculated for each, the annual transmission revenue requirement could be assessed using embedded or long-run marginal cost methods.

For the purposes of this discussion, the transmission cost-of-service presumably is based on embedded costs (i.e., the book costs of the utility's property dedicated to support the transmission system).

For the Boundary Flow method, a $/MW transmission cost is determined by dividing each utility's total annual transmission revenue requirement by its system peak demand, including the wheeling transaction.

The Line-By-Line method utilizes a $/MW-mile unit cost. It is calculated by using the same transmission cost-of-service as the Boundary Flow method, but the divisor is the total system MW-mile number (based either upon the line peak loading or rating) rather than the system peak demand.

Summary of Attributes

Boundary Flow:

- Allocates the embedded costs of the transmission system through the use of load flow models that simulate power flows within an interconnected system.
- The method reflects changes in line losses due to the wheeling transaction.
- Does not reflect the distance of the wheeling transaction.

Line-By-Line:

- Allocates the embedded costs imposed on the transmission system through the use of load flow models that simulate power flows within an interconnected system.
- The method reflects changes in line losses due to the wheeling transaction.
- The method does reflect the distance of the wheeling transmission system.
- All affected parties are identified.

d. Value-Based Rates

(1) The Western System Power Pool Experiment

In the U.S., the use of value-based charges for transmission services has been a rare occurrence in practice where firm transmission is concerned. This is because FERC has traditionally insisted on cost-based justifications for all firm transmission rates that have been submitted to it. However, on two occasions FERC has approved and encouraged "experiments" to determine whether flexible pricing practices for coordination and transmission would encourage and increase efficiency, competition, and coordination. The first occasion, the Southwest Bulk Power Experiment, did not emphasize wheeling costs. The most recent experiment is the Western Systems Power Pool (WSPP). It is an agreement that establishes a multi-state, bulk power market experiment. It provides for flexible pricing of bulk power coordination and transmission services among utility participants.

As approved by the FERC in March 1987, the WSPP is an experiment to test whether broader pricing flexibility for coordination and transmission services will promote increased efficiency, competition, and coordination. Coordination services include economy energy, unit commitment, and firm capacity and energy.

The WSPP does not replace or supersede any of the numerous preexisting contracts among participants, but rather is intended to improve economic efficiency by providing another contract option that enables participants to take advantage of remaining transaction opportunities--those that would not otherwise occur under preexisting contracts. Participation in WSPP transactions is strictly voluntary.

The intended scope of the WSPP is limited to incremental efficiency improvements with respect to the base of existing contractual arrangements among participants. WSPP does not provide for central dispatch of generating units, nor is it intended to ensure dispatch optimization; it is not a pooling of resources to provide for system reliability through centralized maintenance scheduling or other means. Moreover, it is intended as a mechanism for improved coordination among interconnected utilities, not as a mean of resolving transmission access for full requirements customers or other related access issues.

The key feature of the WSPP experiment is the flexible pricing of coordination and transmission services to other participants. Within price ranges established in the agreement, participants are free to charge whatever market-based prices they can negotiate with other participants.

The WSPP agreement also provides for transmission services involving voluntary access at flexible prices. In its filing, the WSPP expressed the view that flexible pricing may more accurately reflect the economic value of various types of transmission service and, thus, may potentially lead to more efficient use of existing transmission facilities. Further, it argued that if flexible pricing extends beyond the time of the experiment, it could provide signals that encourage the development of beneficial new transmission facilities.

The backbone of the WSPP is the EHV transmission network. The WSPP has in excess of 10,000 miles of EHV transmission lines. Since new lines are not being constructed for the Pool, the goal is to use more efficiently the transmission which is accessible. This is the underlying objective of the parties of the WSPP.

The WSPP is unique in that it has provisions for Market Value Transmission (MVT). This transmission service is, by design, capable of allowing the parties to respond to variable market conditions. Provisions have been made for flexible rates, which can be varied hourly, daily or weekly. A Party providing MVT can consider current alternatives, both within and outside of the WSPP, and adjust the rate charged during a given period for the transmission service.

The WSPP agreement provides for three classes of transmission service: non-firm, standby, and firm (or priority), all of which must be prescheduled by the purchaser and the transmitting party. Non-firm transmission is interruptible for any reason during the next scheduled hour or immediately on notification of system emergencies. Standby and firm transmission are interruptible subject to the notice period agreed on by the schedulers and are curtailable for emergencies in accordance with priorities specified in the agreement. Standby differs from firm transmission service in that the transmitting party may use standby transmission for its own use, but only if the purchaser is not scheduling energy. The price for the various types of transmission is as agreed on by the parties, subject to both a floor and a ceiling. The floor is one mill per kWh; the ceiling is 33% of the difference between the highest and lowest decremental costs of generation of the WSPP for the prior year.

The typical uses of the MVT service are:

- Non-firm: transmission scheduled with no energy flows, to permit the purchasers to fulfill operating reserve requirements from remote sources.
- Firm stand-by: transmitting schedules to fulfill operating service requirements of the purchaser's system
- Firm: firm sale/exchange of capacity

While reacting positively to the proposed experiment, the FERC required an independent assessment (and reports to be filed with it) addressing several important questions. These questions concern the experiment's impact on the regional cost of producing electricity; the extent to which, if any, pricing flexibility permits participants to engage in monopoly pricing; and whether simultaneous purchase and resale is an adequate substitute for wheeling. No final conclusions have been reached.

e. Phantom Line

The "phantom line" procedure for pricing wheeling services is based on the assumption that the selling and purchasing utilities have, as an alternative to wheeling through an intervening utility, the possibility of constructing their own transmission. The price for wheeling is based on the costs for the assumed or "phantom line." Formerly, this approach was used to set a price for wheeling between two utilities in British Columbia. The method recently was superseded.

The procedure is quite simple. Its infirmities, however, have greatly limited its practical application. Generalized, rather than specific, costs are used for simplicity. The "phantom" facilities are entirely unrelated to anything that exists. The phantom facilities are also unrelated to reliable service requirements; that is, no outage contingencies are considered.

f. Transmission Over Multiple Systems

Current FERC Policy

FERC has generally established rates, both from the typical method employed in the computation of rates for firm wheeling service and non-firm, on a utility-by utility basis. For rates determined in this manner, the charge for wheeling across two adjacent systems will be in the order of twice the charge for wheeling across a single system, regardless of the distance covered. Some have argued that the transmission costs to all intervening facilities should be pooled and a "joint rate" computed to prevent cumulatively prohibitive wheeling charges.

2.3.2.2 The Billing Determinants

Billing determinants are the factors (such as kilowatts or kilowatt-hours of use) to which rates are applied to determine the charges to a specific wheeling customer. Most tariffs and rate schedules specify exactly how billing determinants are to be measured. A billing determinant is not always based on a customer's actual use. For example, the billing determinant could be based on contract demand kilowatts during the billing period.[41] This would essentially be a take-or-pay arrangement in which the customer's bill would be based on the contract demand kilowatts, even if the actual maximum kilowatt demand imposed by wheeling was much less.

Table 2.4 obtained from a FERC study dated September 1983, shows that the most commonly used billing determinant in firm wheeling arrangements is kilowatt contract

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[41] For a wheeling arrangement, contract demand is the amount of capacity in a rate schedule or tariff service agreement, usually expressed in kilowatts, that the wheeling utility agrees to make available to the wheeling customer for wheeling.

Table 2.4

Selected Features of Existing Wheeling Tariffs and Rate Schedules

Wheeling Utility Tariff or Rate Schedule and Type of Service	Entities Eligible	Scope of Service	Stated Rate ($)	Calculated Annual Rate ($/kw)	Delivery Voltage (kv)	Billing Determinant	Line Loss Adjustment (%)	Penalty Power Factor ($)
Tariffs Bonneville Power Administration Rate Schedule IR-1; firm	All Utilities agreeing to convert to IR-1	Wheeling to, from, and among customers over and through BPA Integrated network and over Pacific Intertie					Cont. dem. for kw charge and kwh deliv. for kwh charge	
Network Service			.1749/kw/mo. & .00056/kwh					
Intertie Service			.3024/kw/mo. & .00081/kwh					
Clev. Elec. Illum. Co. Vol. No. 1; Firm	Munis & coops in CAPCO[1] ter.	Wheeling to, from, & among customers	$1.69/kw/mo.	$20.28		cont. dem.[2]	2	near unity

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[1]. CAPCO is the Central Area Power Coordination Group. The members companies are CEI, Toledo Edison Company, Duquesne Light Company,Ohio Edison Company and Pennsylvania Power Company.

[2] Contract demand

Table 2.4

Selected Features of Existing Wheeling Tariffs and Rate Schedules

Consumers Power Co. Firm, Vol. No. 2	Elec. Util. in CP serv. ter.	Wheeling to, from & among customers	.222/kw/wk. .318/kw/wk.	11.54 16.54	> 138 46	cont. dem.	2.77 4.62	
Interruptible Vol. No. 3	Elec. Utili. in CP serv. ter.	Wheeling to, from & among customers; not available for certain types of power.						
Weekly			.172/kw/wk .248/kw/wk	8.94 12.90	> 138 46	cont. dem.	2.77 4.62	
Hourly			.00125/kwh .0017/kwh		138 46	kwh del.	2.77 4.62	
Economy Energy			15% of savings		138	savings to customers		
Florida Power Corp. Vol. No. 1	Elec. Util. Interconnected with FPC	Wheeling to, from & among customers						97
firm			.797/kw/mo. extra charge	9.56 13.32 max.	> 69 <12-69	cont. dem. or max. kw		
nonfirm			.00109/kwh extra charge		> 69 <12-69	kwh deliv.		
Florida Power and Light Co. Vol. No 2; Firm	Munis Coops IOUs	Wheeling to, from, & among customers & through FP&L service territory					System ave. loss, but may use incremental loss	Near unity
Firm (Schedule TD)			1207.25/mw/mo.	14.49		cont. dem.		
ST. Firm (Schedule TB)			39.69/mw/day	14.49		cont. dem.		
Emergency (Schedule TA)			1.65/mwh			mwh deliv.		
Economy Energy (Schedule TL)		Limited to econ. eng. power	1.65/mwh			mwh deliv.		

Table 2.4

Selected Features of Existing Wheeling Tariffs and Rate Schedules

New England Power Co. Vol. No. 3: Nonfirm Rate T-PTF	Elect. Util.	Wheeling to, from & among customers & through NEPCO service territory; only for nonfirm power; other conditions stated. Use PTF facilities.[3]	NEES cost/kw/mo.	6.21	> 69	cont. dem.		
Rates T-Non PTF 1, 2 & 3		Use non PTF facilities.	Extra charges	3.60 max.	varies	cont. dem.		
New England Power Pool Rate Schedule No. 2 firm	Members of NEPOOL	Limited to PTF facil. Wheeling of hourly service or certain entitlements to members	formula/kw/mo.		> 69			
Nonfirm		Wheeling of certain entitlements to or from members.	formula/kw/mo.		> 69			
Otter Tail Power Co. Vol. No. 3; firm	Muni. In OT Serv. Ter.	Wheeling to and among customers	1.306/kw/mo.	15.67	41.6	Max. kw with 90% rachet	7%	Penalty not based on certain %.
RATE SCHEDULES Kentucky Utilities Schedule No. 92; Nonfirm[4]	2 Coops	Only for wheeling between the 2 coops & only for certain types of power.	.001/kwh		138	kwh deliv.		

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[3] PTF facilities are the transmission facilities rated at 69 kv and above (with certain exceptions) owned by members of NEPOOL which are required to allow energy from significant power sources to move freely on the New England transmission network.

[4] This service is referred to as excess capacity service in the rate schedule.

Table 2.4

Selected Features of Existing Wheeling Tariffs and Rate Schedules

Long Island Lighting Co. Schedule No. 32 Firm Interruptible	PASNY[5]	Only for wheeling from PASNY to munis in LILCO Serv. Ter.	2.14/kw/mo. 1.63/kw/mo. 2.93/mwh	25.68 33.24	distribution	Cont. dem. mwh deliv.	System average	90
Mississippi Power & Light Schedule E LT. firm ST. firm Nonfirm		Wheeling to, from & between the two munis	.75/kw/mo. 1.25/kw/wk .175/kw/wk 1.058/kw/mo. . 001/kwh 1.003/kwh	9.00 12.00 9.00 12.00	115 < 13.8 115 < 13.8 115 < 13.8	Cont. dem Cont. dem. Cont. dem.	3	
Southern California Edison Schedule No. 83 Interruptible	1 muni	Wheeling to muni of non-firm energy purch. from Nev. Power.	.00122/kwh can increase if rate of return increases.		220		3.3 1	

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[5] PASNY is the Power Authority of the State of New York.

demand. However, for five of the arrangements, other billing determinants are specified. For BPA schedules FPT-2 and UFT-2, the billing determinant for a particular month is the highest of contract demand, maximum kilowatt use, or 100%, 11-month ratchet demand.[42] The Otter Tail tariff uses the highest of the customer's maximum kilowatts of wheeling service during the billing period or a 90%, 11-month ratchet demand. Florida Power Corporation uses the higher of contract demand or maximum use. The only tariffs which use billing determinants not based on kilowatts are Florida Power & Light Company's (FP&L's) emergency and economy energy services. For these, FP&L uses actual megawatt-hours delivered as the billing determinant. However, for the other two types of firm service offered in its wheeling tariff, FP&L uses contract demand.

For interruptible service, the most common billing determinant is actual kilowatt-hours delivered. Two exceptions are Consumers Power (CP) Vol. No. 3 weekly service and New England Power Pool (both conditionally interruptible tariffs). Both use kilowatt contract demand. Another exception to actual kilowatt-hour delivery is the billing determinant for interruptible or non-firm service for CP Vol. No. 3 Economy Energy Service. The charge for this service is 15 percent of the savings in power costs realized by the customer.

The billing determinant stated in the transmission service rate establishes the basis for measuring the amount of capacity provided to be used in computing an invoice. Billing determinants taken from actual rates are:

1. Maximum monthly demand coincident with company's maximum 60- minute peak.
2. Contract demand.
3. Weekly contract demand per service agreement.
4. Kilowatt hour usage.
5. Fifteen percent of savings.

2.3.2.3 The Pricing Basis

Pricing bases represent the rationale behind the wheeling rates. Table 2.5 summarizes the most common pricing bases in use. The importance of the selection of a pricing basis is in what kind of wheeling it encourages and discourages.

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[42] A 100-percent, 11-month demand ratchet means that 100 percent of the highest kilowatt use during the previous 11 months can be used as the billing determinant for the current month.

TABLE 2.5

Alternative Pricing Bases for Transmission Service

1. Embedded Costs (Present FERC Method)

   - All transmission costs "rolled in"
   - Allocation is by coincident peak demand
   - Based on original cost less depreciation

   - can lead to increased costs for existing customers
   - does not provide incentive for new lines
   - does not account for reductions in other savings
   - provides incentive to build generation at wrong locations

2. Short-Run Marginal Cost

   - includes cost of incremental losses
   - includes incremental O&M and administrative costs
   - includes other fuel costs, e.g., additional spinning reserves, altered dispatch, regulation, etc.
   - includes opportunity costs for reductions in cost-saving transfers
   - may include congestion costs

3. Long-Run Marginal Cost

   - includes carrying charges for facilities expansion
   - includes same types of cost as short-run marginal cost.
   - gives less weight to near-term costs.

4. Value-Based or Market-Based Pricing

   - examined in WSPP experiment [43] - bids and offers
   - may include open bidding for transmission rights

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[43] Refers to Western System Power Pool Experiment, sponsored by the Federal Energy Regulatory Commission.

a. Embedded Cost Pricing of Transmission Service

Embedded-cost transmission rates are generally developed by applying an appropriate fixed-charge rate to book (net or gross) investment in transmission facilities and dividing the results by some measure of the use of the transmission system such as the annual peak load including the firm wheeling load on the transmission system. This rate per kW of firm wheeling service reflects some measure of the "responsibility" of wheeling customers for the investment in the transmission system such as usage at the time of peak load on the system.

This policy is based on the notion that wholesale requirements and wheeling customers are served by the entire integrated transmission system rather than some portion of the overall system. Therefore, it is argued, the rates paid by those customers should reflect an allocation of total transmission costs.

Problem With Exclusive Reliance on Embedded Cost Pricing

The principal disadvantage in the use of an embedded cost methodology in establishing wheeling rates is that it tends to understate the costs of providing the service. For most systems, the embedded, historical cost of transmission capacity is less than the cost of additional transmission capacity, i.e., incremental costs. Therefore, a new service requiring an expansion of transmission capacity will tend to carry a price less than the true cost of service provided. If the utility is to continue to recover its embedded costs, this can only be accomplished at the expense of increased prices to existing customers.

Embedded costing procedures, as traditionally applied, also ignore or understate various generation-related costs associated with wheeling which are difficult to quantify, but which may be quite significant. For example, the incremental losses associated with a new transmission service could be much higher than the average losses on the system. Prices that include only average transmission losses will therefore often fail to recover the full cost of the service.

Finally, embedded cost pricing as traditionally applied does not reflect the financial losses in the form of unrealized savings due to the unavailability of the transmission facilities for opportunity sales and purchases. In the absence of the wheeling service, such savings could serve to reduce the net cost of serving the other customers of the utility.

Because embedded costs often fail to recover the full costs of providing the transmission service, reliance on such pricing for wheeling service can lead to unsatisfactory results in some cases. For example, embedded cost-based price signals that bear little or no relation to the cost of expanding transmission capacity may contribute to decisions by producers (including IPPs) to invest in generating capacity that would not be built if the wheeling service were priced in accordance with the cost of incremental transmission capacity.

b. Value-Based or Market-Based Pricing

These concepts have been adequately discussed earlier in connection with the WSPP experiment.

2.3.3 Bidding for Transmission

Currently, most transmission rates are based on costs rather than value. However, the acceptance of the Baltimore Gas & Electric Company's (BGE's) sale of transmission service to Public Service Electric & Gas and to Atlantic City Electric on the basis of competitive bids has opened the door to value-based pricing of transmission rates. Under this plan the utility offers (to other joint owners of the Pennsylvania-New Jersey-Maryland (PJM) EHV transmission system) shares of its entitlement for use of the PJM transmission system for the purpose of importing energy from the west. An open telephone auction is conducted by BGE on a monthly basis. Entitlement to the use of BGE's share of PJM transmission capacity is awarded to the highest bidder, or to successively lower bidders to the extent the highest bidder bids for less than the total amount of the company's entitlement. Such a procedure has the effect of allocating scarce transmission capacity to users which have the highest and best use of the transmission capacity.

2.3.4 Actual Rates

In this section, some examples of actual rates and wheeling agreements will be presented, as well as a sample list of contract terms to be negotiated in drawing up a wheeling agreement between utilities.

1. Selected Transmission Agreements

A sampling of transmission agreements published by the FERC, Office of Electric Power Regulation, in August 1984[44] is given in the Casazza, Schultz & Associates, Inc. report to the National Energy Board, 1990.

2. Federal Systems Wheeling Rates

The Federal power systems in the United States, which include the Tennessee Valley Authority (TVA) and a number of Power Marketing Agencies such as the Bonneville Power Administration (BPA) and the Western Area Power Administration (WAPA) are deeply involved in power wheeling due to the widely scattered nature of both their power resources and their customers. The following is a review of some typical Federal agency wheeling rates based on a study performed by the U.S. Department of Energy (DOE) in 1984[45] and summarized in a report published by the National Regulatory Research Institute.[46]

The Bonneville Power Administration (BPA) at the time of the DOE- sponsored study used three rate schedules for wheeling services that it provided. The Formula Power Transmission (FPT-1) rate schedule was a multi-part rate that consisted of a Main Grid Charge for use of facilities of greater than 115 kV, a Secondary System Charge for use of facilities of 115 kV or less, and an Intertie Charge for use of the Pacific Northwest-Pacific Southwest Intertie. The Main Grid and Secondary System rates included charges per kilowatt and a rate per mile ($0.135/mile for Main Grid and $0.036/mile for Secondary System). The Use-of-Facilities Transmission (UFT-1) rate schedule applied to the use of specific portions of the BPA transmission system (referred to as the Federal Transmission System). The monthly charge per kilowatt was set equal to one-twelfth of the annual cost per kilowatt of the capacity of the facilities. The Energy Transmission (ET-1) rate schedule covered transmission (using excess capacity of the Federal Transmission System) of non-firm energy from other utilities. The rate varied depending on the portion (Main Grid, Secondary System, or Intertie) of the transmission system used. The range, at the time of the survey, was from 0.75 mills/kWh for the Main Grid to 1.25 mills/kWh for the Intertie.

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[44] "A REVIEW OF SELECTED TRANSMISSION AGREEMENTS", Federal Energy Regulatory Commission, Office of Electric Power Regulation, Washington, D.C., 1984.

[45] Richard C. Tepel et al., ANALYSIS OF POWER WHEELING SERVICES, prepared for the U.S. Department of Energy, November 1984, Appendix I.

[46] SOME ECONOMIC PRINCIPLES FOR PRICING WHEELED POWER , The National Regulatory Research Institute, Columbus, Ohio, August 1987.

The Western Area Power Administration (WAPA) markets power from hydroelectric facilities and one coal-fired facility in the West. The WAPA has negotiated a series of agreements with investor-owned utilities and generation and transmission cooperatives. These utilities wheel full or partial requirements power to preference customers of the WAPA, charging (at the time of the survey) 1 mill/kWh for scheduled transmission. The WAPA markets power from four projects that also have their own transmission systems. Wheeling is provided for non-preference customers over these systems. Rates have been set for non-preference customers for one of those systems (the Parker-Davis System in Arizona). At the time of the DOE-sponsored survey, firm service was provided for $3.67/kW/month. Non- firm service was provided for 1.3 mills/kWh. Charges for firm and non-firm wheeling service in other parts of the WAPA system were negotiated by the parties involved. Rates were 1 mill per kilowatt-hour for firm and non-firm services in some instances, and $5.30 per kilowatt per year for firm service in other cases.

The Southwestern Power Administration (SWPA) markets power from hydro projects in the Southwest, and it is required by the Flood Control Act of 1944 to wheel non-federal power over any excess transmission capacity that it may have. Wheeling service at the time of the DOE- sponsored study was being provided under Rate Schedule TDC-2, a postage stamp rate approved by the FERC. Under this schedule, charges were based on the specific facilities used. Rates differed by the voltage of the transmission line used and the amount of transformer service required. Interruptible service was being provided at a rate 5 percent lower than firm service.

The Tennessee Valley Authority (TVA) wheels power received from Big Rivers Electric Power Corporation to Alabama Electric Cooperative and South Mississippi Electric Power Association. At the time of the survey, the TVA was charging 20 cents per week per kilowatt of the maximum aggregate hourly amount of power scheduled for

transmission and 0.22 cents per kilowatt-hour for miscellaneous energy that may also be transmitted. A customer charge of $1,000 per month was also being assessed.
The Alaska Power Administration (APA) markets hydroelectric power generated by two projects. The APA has arranged wheeling of the power by third parties to its preference customers. The customers receive long-term firm access to the power in order to satisfy their wholesale requirements. Rates at the time of the DOE study were being assessed in mills per kilowatt-hour.

The Southeastern Power Administration (SEPA) is responsible for marketing power from various reservoir projects, and it has negotiated contracts with investor-owned utilities to wheel power. The SEPA has no transmission facilities of its own. Transmission rates are mileage-based with the charge per kWh increasing as the distance between reservoir and delivery point increases. Three zones are established going out from each reservoir. The first zone covers a 100-mile radius from the project; the second, 101 to 150 miles; and the third, greater than 150 miles. Charges at the time of the survey increased from 1.00 mill/kWh for delivery in the first zone, to 1.75 mills/kWh for the second zone, to 2.5 mills/kWh for the third.

3. Other Rates Not Reviewed by FERC

The New York Power Authority (NYPA) generates and markets power from hydroelectric, nuclear, and fossil fuel plants. The NYPA provides power requirements for municipalities and rural cooperatives and has entered into wheeling contracts with investor-owned utilities to supply the power to its customers. Each utility charges for the wheeling service that it provides, and the charges are paid by the Authority. The NYPA also purchases power from Hydro-Québec for resale to seven New York investor-owned utilities and two preference customers on Long Island. The NYPA transmits the power to the Niagara-Mohawk Power Corporation, charging (at the time of the DOE survey) 1 mill per kilowatt-hour.

A recent case in Florida provides a final example of non-FERC wheeling rates. The Florida Public Service Commission approved in April 1986 Florida Power's and Tampa Electric's wheeling rates for cogenerated power. Florida Power's rate for firm service was approved as $1.148 per kilowatt per month. Its non-firm service rate was approved as 1.57 mills per kilowatt-hour. Tampa Electric's rates were $1.225 per kilowatt per month for firm service and 2.5 mills per kilowatt-hour for non-firm service.

4. Contract Terms To Be Negotiated

In the negotiation of a wheeling contract, a variety of terms and conditions of service must be taken into account. These will reflect the needs and desires of the producer and purchasing utility, as well as circumstances of the wheeling utility. Many conditions of service will be interrelated, and negotiation and compromise will be necessary. For example, the willingness of a utility to enter into a long-term contract may depend on the provisions of the contract relating to the utility's ability to effect changes in rates. A list of some of the terms and conditions to be negotiated in most wheeling contracts is given below. It is taken from a monograph published by the Edison Electric Institute [47] which represents a well thought-out survey of the requirements. A full description of the terms is given in the Casazza, Schultz & Associates Inc. report to the National Energy Board.

a- Term of Service

b- Degree of Interruptibility

c- Provisions for Changing Rates

d- Provisions for Modifications to Transmission Capability

e- Maintenance Coordination Provisions

f- Standby Provisions

g- Provisions for Method of Determination of Transmission Losses

h- Other contract terms
  - Power Factor Corrections
  - Reservation Provisions
  - Administrative Provisions
  - Force Majeure Provisions
  - Indemnification Provisions

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[47] PRICING OF TRANSMISSION SERVICES IN BULK POWER MARKETS: FACTORS FOR CONSIDERATION , Edison Electric Institute, Washington, D.C., December 1987.

2.4 Wheeling in Canada and Comparisons With the United States

This section discusses the differences between wheeling in the United States, as described in Sections 2.3, and wheeling in Canada. It addresses differences in motivations, in regulatory situations, and in physical factors; it describes the present Canadian facilities available for wheeling and the use that is being made of them; and it summarizes the views on wheeling of Canadian utilities and other interested parties.

2.4.1 Canadian - United States Comparisons

As a principal purpose of this study is an examination of the applicability of United States wheeling practices to Canada, consideration must be given to the similarities and dissimilarities between the situations in the two countries that bear on motivations to encourage wheeling, and on the problems and practicability of its use.

1. Utility Structure

In the United States, some 230 investor-owned utilities (IOUs) produce about 75% of the electricity generated. In addition, there are about 1800 municipal utilities and 900 rural distribution cooperatives. In general, the IOUs are vertically-integrated with generation, transmission, and distribution functions. Customer interests are protected by regulatory process which sets customer rates so as to provide the IOUs with an appropriate return on investment.

In Canada, most of the utilities are publicly-owned. In 1989, eight provincially-owned utilities produced more than 80% of electricity generated, and IOUs about 7.5%. The provincial utilities are mainly vertically-integrated, and may serve all types of loads somewhere in the province. As a result, there are few rural electricity cooperatives. Independent municipal systems, where they exist, buy most of their electricity from the provincial utility. Customer rates are regulated so as to achieve efficiency and financial soundness in the supply entities.

2. Federal Regulatory Authority

In the United States, federal regulation of electricity transactions began in 1935 with passage of the Federal Power Act, which gave the Federal Power Commission (predecessor of FERC) authority to regulate inter-state sales and transmission arrangements by IOUs.

FERC was also given the duty to promote and encourage interconnections and coordination, and the authority to order utilities to interconnect, although only under very constrained circumstances.

In Canada, as defined in the Constitution Act, the federal government has jurisdiction over electricity exports, and this function, among others, is performed by the National Energy Board. The federal government also has jurisdiction over interprovincial trade and thus would appear to have jurisdiction over interprovincial electricity transactions. The federal government has not, however, provided the National Energy Board or any other agency with regulatory authority over interprovincial electricity trade, so that any federal authority has not, in fact, been exercised.

The Board does not have authority to order wheeling of electricity for export, but the NEB Act does confer power on the Board that may be used to facilitate wheeling. The Board has jurisdiction over international transmission lines, and can therefore grant authorization to construct an export-dedicated transmission line originating in one province and traversing the territory of another province en route to the export market.

Also, the Board has the power to certify and approve a transmission line to be constructed for the purpose of interconnecting utilities in two provinces through an intervening province if the Governor in Council (not the Board) makes a determination that the NEB Act should apply.

3. Federal Approaches

Increasing global competition has led many governments to seek ways to improve the economic efficiency of their electricity supply systems. One school of thought argues that one way to achieve greater efficiency is to introduce competition and market responsiveness.

In Canada, the Advisory Committee on Energy Options, whose recommendations provided an impetus for this study, argued for "market-responsive energy development trade and use."[48] In the United States, the Transmission Task Force of the FERC adopted "economic efficiency (and) the mitigation of market power. . ." [49] as criteria for evaluation of proposed wheeling methodologies.

Despite apparent similarities in their general approaches, however, there are significant differences in the ways in which wheeling is approached by the two federal governments.

In the United States:

- a main regulatory concern is the mitigation of the market power of IOUs. For the generation component, this can be at least partially accomplished by the competition provided by independent power producers (IPPs).
- in some instances, the production from IPPs would be sold to IOUs, but in many instances it would be sold directly to the municipal systems and rural distribution cooperatives that would otherwise be customers of the IOUs.
- there are strong advocates of deregulation of the transmission component of the IOUs, on the basis that access to this transmission for wheeling is necessary to ensure that the IOU owners cannot thwart their generation competitors.
- regulators must also address the concerns of the IOUs. The wheeling of unregulated IPPs' production on the IOU's transmission facilities raises concerns about unacceptable complications to IOU's planning and operation, about concealment of system data for competitive reasons, and about consequent degradation of electricity supply reliability.
- the capture of IOUs' loads made possible by wheeling of generations by IPPs raises concerns about stranded investment and possible disallowance of little-used facilities from the IOU's rate base.

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[48] ENERGY AND CANADIANS: INTO THE 21ST CENTURY , Advisory Committee on Energy Options, 1988.p.33.

[49] ELECTRICITY TRANSMISSION: REALITIES, THEORY, AND POLICY ALTERNATIVES , Transmission Task Force, FERC, 1989, p. 104.

- FERC has been unable, despite extensive examination of alternatives, to resolve the contradictory concerns about transmission wheeling, and rather than adopt standard or preferred methodologies under these circumstances, will apparently let policy evolve over time as it reaches decisions on individual cases.

In Canada:

- the virtual absence of independent municipal systems with their own generation and rural distribution entities means that competition in the generation segment is between IPPs and the utilities' own generation expansion alternatives for places in the overall generation supply programs.

- in this situation, there are not the same concerns about wheeling IPPs' production as exist in the United States, and indeed, the siting of IPPs on the transmission system can be influenced by the rate structure so as to achieve transmission benefits.

- the Statement of National Power Policy contains two essential concepts:

  > "First, encouraging development of large low-cost power sources and the distribution of the benefits thereof as widely as possible through interconnections between power systems within Canada; second, encouraging power exports and interconnections between Canadian and United States power systems where such induce early development of Canadian power resources."[50]

- there is thus a stronger thrust in Canada than in the United States to achieve efficiency by encouraging inter-utility cooperation in generation expansion planning, thereby expanding the range of available alternatives and potentially providing benefits through economies of scale, hydro-thermal synergism and the like. Wheeling may be required to effect cooperative generation expansion.

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[50] STATEMENT OF NATIONAL POWER POLICY, Honorable Mitchell Sharp, Minister of Trade and Commerce, October 8, 1963.

- there is thus also a major thrust in Canada that does not exist in the United States, i.e., the achievement of increased efficiency within Canada by utilizing the profits from exports to reduce Canadian electricity costs, and by recapturing the output of the generation assets, when needed by Canada, at depreciated costs. Wheeling may be required to effect delivery of exports.

4. State/Provincial

Both states and provinces have constitutional powers to regulate trade, including electricity, that takes place within their borders. In the United States, interstate commerce in electricity is regulated by the federal agency, FERC. In Canada, as noted earlier, the federal government has not exercised authority in interprovincial electricity trade.

State/provincial control is, in general, exercised in two areas, the setting of rates for customers, and the granting of approvals for construction of generation and transmission facilities.

5. Federal versus State/Provincial Conflicts

It is not unreasonable to state that a goal of the federal governments in both countries is the achievement of minimum cost supply of reliable electricity. State and provincial goals could be stated similarly, but applicable within their own jurisdictions for the citizens of the state or province. The federal and provincial goals will thus, at times, be incompatible.

The preponderance of provincially-owned utilities in Canada has led to another potential source of conflict; the use of the utilities to achieve provincial social goals.[51] This can widen the gap between federal and provincial goals.

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[51] The Energy Options Advisory Committee found that "Some governments had come to rely too heavily on Crown Electric Corporations, not only as instruments to build the economy by providing power at least cost, but also as a source of social and distributional benefits" and that problems that have emerged include "a preference for developing provincial resources sometimes for energy security reasons, can discriminate against lower cost sources in other provinces. . ." and "a focus on provincial job creation and economic benefits leads to over-capacity if expansion plans are not based on market demand."

6. Geographic Factors

There are about 230 IOUs in the United States and only 17 major utilities in Canada. Canadian utilities serve quite large geographic areas relative to their United States counterparts. Canadian utilities are arranged, in the main, as an east-west chain so that most abut only two other Canadian utilities. There is no particular geographic orientation to utilities in the United States, and many utilities have a significant number of interconnections with other utilities in all directions.

There are, thus far, greater opportunities for inter-utility wheeling in the United States than in Canada. The Canadian utility with the greatest number of potential wheeling paths is New Brunswick Power which is interconnected with three other Canadian utilities and with three utilities in Maine. By contrast, the American Electric Power Company (AEP) in the United States is interconnected with 22 other utilities via 116 transmission circuits.

The large service areas of Canadian utilities reduce their potential for wheeling because the cost of wheeling across the long distances typical of their transmission systems can substantially offset or even exceed the difference between the marginal costs of generation at the ends of the wheeling path. The difference in transmission is illustrated by the fact that the average length of transmission lines in Pennsylvania is 12 miles whereas in Ontario the average is 36 miles.

2.4.2 Interconnection Facilities

The transmission circuits connecting utilities together are commonly called "interconnections," and it is these interconnections that are used to effect all inter-utility electricity-related transactions, including wheeling.

Most of the Canadian interconnections and Canadian-U.S. interconnections are alternating current (AC) interconnections. Most operate in parallel with other transmission paths and thus carry a share of the total electricity transfer that varies with the impedances of the various parallel paths, i.e., in accordance with the "laws of physics" described in an earlier section of this report. Some are radial AC interconnections, i.e., have no other transmission paths in parallel, and thus simply transmit the electricity that is input to them.

Some of the AC ties incorporate "phase shifters" which provide a measure of control over the division of flow among the various parallel paths.

A number of the interconnections are direct current (DC) interconnections. The use of DC provides full control of the electricity flow on the interconnections. DC transmission is more expensive than AC transmission except for situations where large blocks of electricity have to be transported over long distances (hundreds of kilometres). DC transmission is also used for interconnections in circumstances where, for technical reasons, AC transmission is unable to provide a satisfactory interconnection.

The present interconnections between Canadian utilities and between Canadian and U.S. utilities, together with the type of facilities employed and capability to transfer electricity, are shown schematically in Figure 2.7.

As noted in an earlier section, Canada and the United States are supplied, in the main, from four large groups of synchronously interconnected utilities, i.e., the Eastern and Western interconnected systems, the Québec system and the Texas system. AC transmission links between the Eastern and Western interconnected systems are not strong enough to maintain synchronism between these two large systems, so that transfers between the two are effected by configuring the AC ties for radial operation, or by the use of DC transmission.

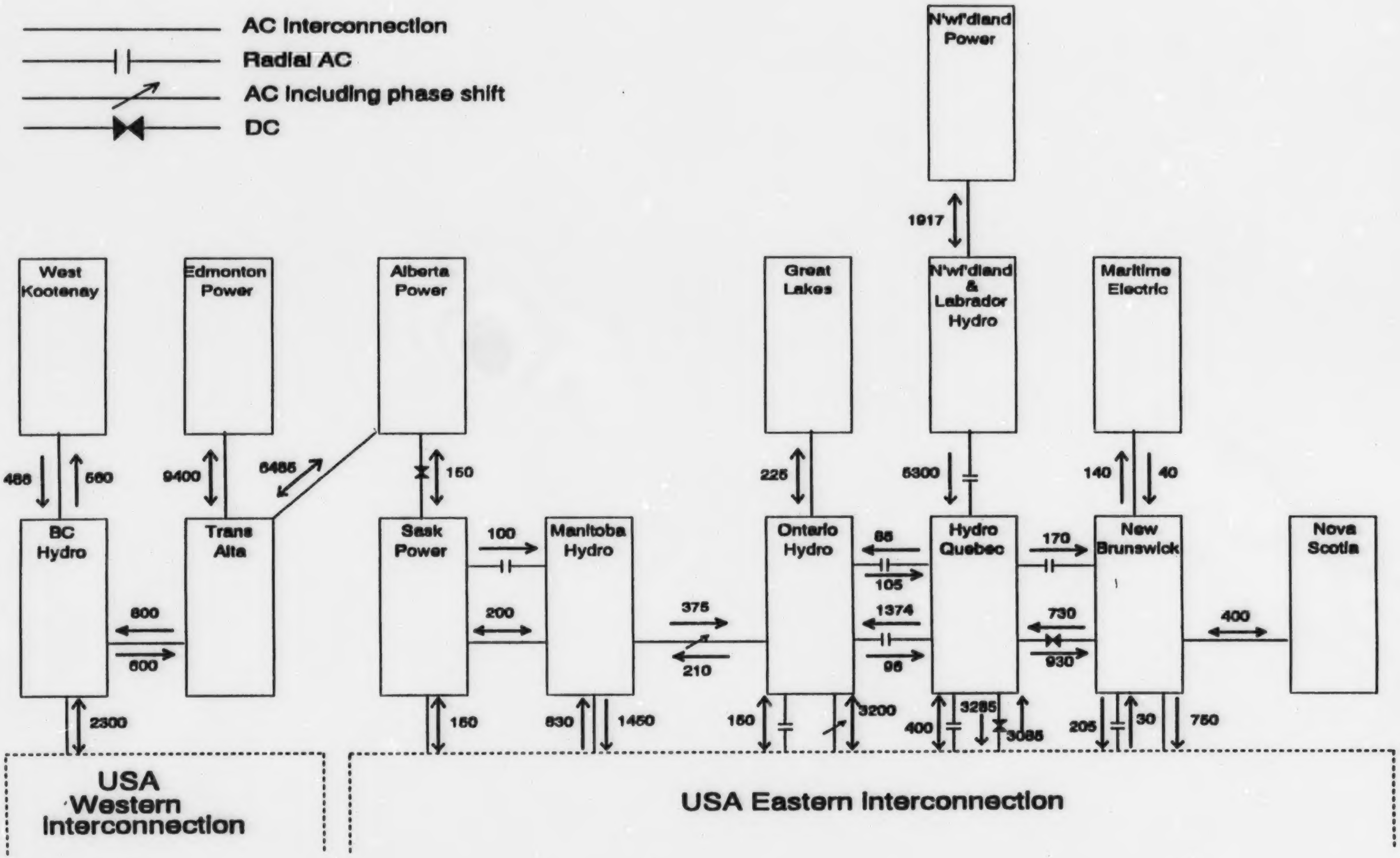
British Columbia and Alberta utilities are members of the Western interconnected system, and are connected via a DC link to Saskatchewan in the Eastern interconnected system.

SaskPower, Manitoba Hydro, and Ontario Hydro are interconnected east-to-west by AC interconnections and to the balance of the Eastern interconnected system by AC interconnections to adjacent United States utilities. Maritime Electric in Prince Edward Island and Nova Scotia Power are also part of the Eastern interconnected system via their AC ties with New Brunswick Power and thence, via the New Brunswick Power AC interconnections, with utilities in Maine.

Hydro-Québec is not part of the Eastern interconnection as its system does not operate in synchronism with neighbouring utilities. Interconnections are either radial AC or DC.

Figure 2.7

CANADIAN INTERCONNECTIONS
TRANSFER CAPABILITIES, NORMAL CONDITIONS


AC Interconnection
Radial AC
AC Including phase shift
DC
N'wf'dland Power
1917
West Kootenay
Edmonton Power
Alberta Power
Great Lakes
N'wf'dland & Labrador Hydro
Maritime Electric
486
560
9400
5485
150
225
5300
140
40
BC Hydro
Trans Alta
Sask Power
Manitoba Hydro
Ontario Hydro
Hydro Quebec
New Brunswick
Nova Scotia
100
200
85
105
1374
95
170
730
930
400
800
600
375
210
2300
150
830
1450
150
3200
400
3285
3085
205
30
750
USA Western Interconnection
USA Eastern Interconnection

Newfoundland utilities, with the exception of the Churchill Falls generating station in Labrador which is connected radially to Hydro-Québec, operate as a completely independent system, as do the utilities in the Yukon and Northwest territories.

Examination of Figure 2.7 leads to the following general observations:

- excluding those situations where the interconnection capacity between utilities results from a sharing of the transmission used to service loads, i.e. within Alberta and Labrador and excluding the Newfoundland-Québec interconnection which exists only to deliver Churchill Falls output to Québec, the total interconnection capability between all Canadian utilities (about 5500 MW) is much less than the total interconnection capability between Canadian and United States utilities (about 12000 MW).

- considering only contiguous utilities as potential wheeling sources, Canadian utilities with present ties to United States utilities have only two to four possibilities to provide wheeling services to or from United States utilities. (It is possible for there to be more than one wheeling utility in tandem between the supplying system and the using system, but the cost of providing wheeling service usually imposes a practical limit on one, or perhaps two, intervening systems.)

- the possibilities for wheeling between Canadian utilities are rather limited. Again, excluding the load-serving interconnections within Alberta and Newfoundland, the maximum number of contiguous Canadian utilities for any one utility is three (New Brunswick Power). The number of possible wheeling paths through any utility increases rapidly with the number of contiguous utilities. For two contiguous utilities, there is one possible wheeling path, for four there are six paths, and for six there are fifteen paths. Examination of Figure 2.7 also points out Canadian situations that are particularly worthy of note:

  - Maritime Electric and Nova Scotia Power cannot access any other Canadian or United States utility except via New Brunswick Power.

- Newfoundland and Labrador Hydro cannot access any other Canadian or United States utility except via Hydro-Québec.

- the Alberta utilities cannot access U.S. utilities except via B.C. Hydro.

2.4.3 Interconnection Transactions: Types and Levels

Interconnection transactions can be categorized as "firm" (delivery is essentially guaranteed), "interruptible" (no guarantee of delivery; delivery at sole discretion of seller) and "other" (delivery curtailment possible under specified conditions).

The level of interconnection transaction between two utilities can vary markedly from year to year for many reasons, including the following:

- variations in firm contract amounts;
- variations in load;
- variations in hydraulic conditions;
- variations in generator availability due to commissioning, decommissioning and maintenance;
- variations in fuel availability and cost; and
- variations in transmission availability.

Figure 2.8 gives the 1988 values of all categories of interprovincial and international transactions. Table 2.6 gives the breakdown of Canadian export transactions by category.

TABLE 2.6
CANADIAN EXPORT TRANSACTIONS BY CATEGORY
1988 exports GW.h

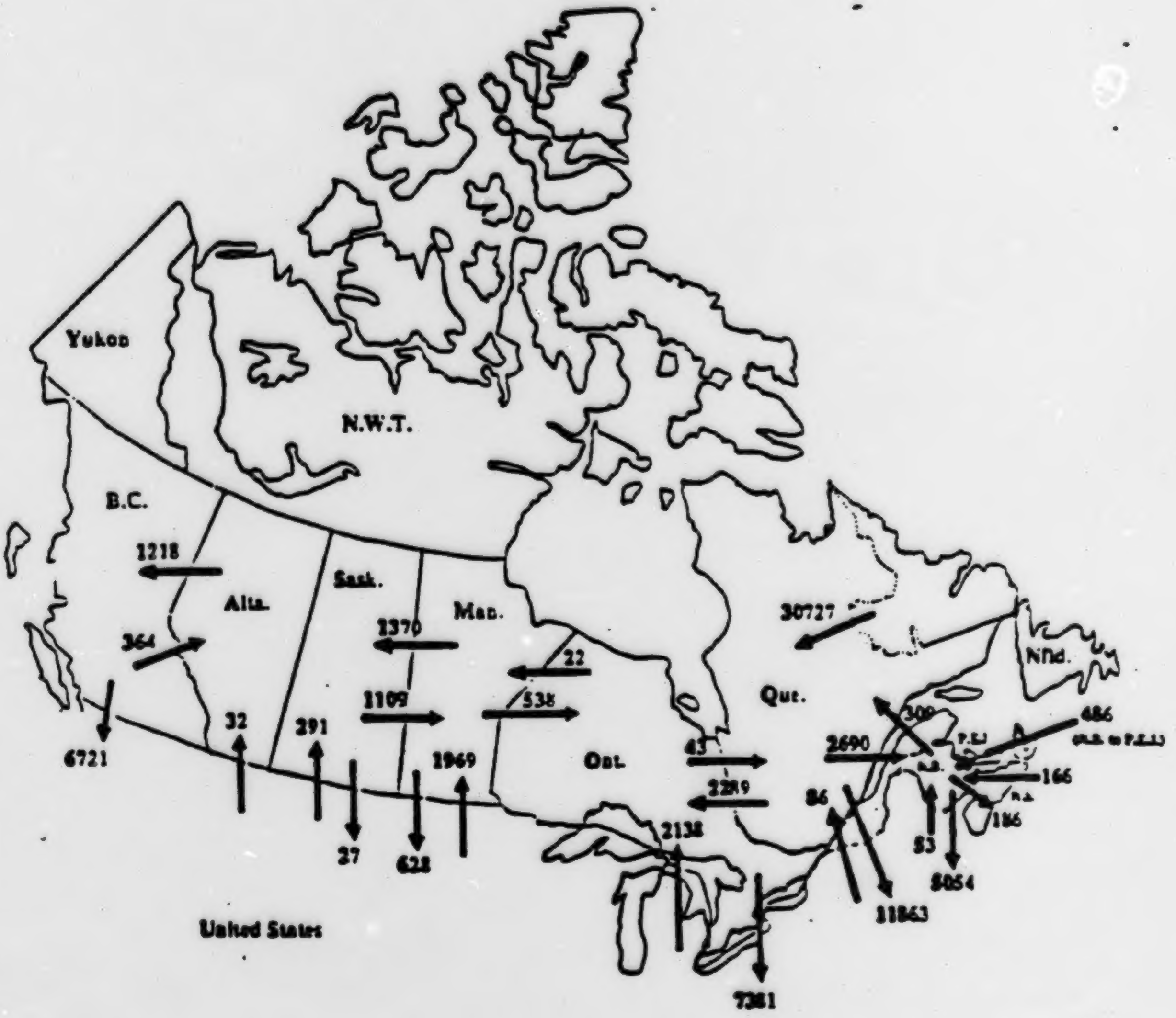
	Firm	Interruptible	Other	Total
New Brunswick	2522	1159	1372	5053
Québec	4921	3259	3685	11865
Ontario	384	5239	0	5623
Manitoba	343	380	0	723
Saskatchewan	0	1	0	1
British Columbia	161	6203	0	6364
TOTALS	8331	16241	5057	29629

Figure 2.8

INTERPROVINCIAL AND INTERNATIONAL TRANSFERS OF ELECTRICITY

1988 (GW.h)

Interprovincial transfers: 49 201 GW.h
Exports to U.S.: 31 673 GW.h
Imports from U.S.: – 4 470 GW.h


Yukon
N.W.T.
B.C.
Alta.
Sask.
Man.
Ont.
Que.
Nfld.
P.E.I.
N.B.
N.S.
United States
1218
364
6721
32
291
27
2370
1109
628
1969
22
538
43
2289
2138
7381
30727
2690
86
11863
309
486
(N.B. to P.E.I.)
166
186
83
8054

* Includes non-cash exchanges

2.4.4 Wheeling by Canadian Utilities

Wheeling can be either "direct" or "indirect (buy-sell)."

Direct wheeling is the movement of energy from one party through the transmission system of an intermediate party (or parties) for delivery to a third-party. The intermediate party collects a fee or fees for the reservation and use of its transmission system but does not otherwise participate in the transaction, and its generation levels are unchanged.

Indirect wheeling (buy-sell) is the sale of energy from one party to an intermediate party (or parties) who then sells it to a third party. It occurs when the intermediate party is in a position to buy the energy at a price between the seller's cost and the buyer's value. The intermediate party collects a share of the difference in price between the buyer and the seller that may substitute for, or provide more revenue than, direct wheeling, and its generation levels are unchanged.

Wheeling can either be "firm" or "non-firm."

Firm wheeling is the guaranteed delivery of energy through the intermediate party, with the possible exception of curtailment upon the loss of transmission facilities.

Non-firm wheeling is the delivery of energy through the intermediate party with curtailment or interruption for specified or unspecified conditions on the intermediate party's system. The specified conditions could include equipment loading and cost.

The amount of wheeling undertaken by Canadian utilities has been minimal, and to a considerable extent for border accommodation rather than for commercial purposes. The total of interprovincial and international energy transfers in 1988 was 77,679 GWh. Of this, wheeling identified by Canadian utilities consisted of the following:

For Border Accommodation	
B.C. Hydro to B.C. Hydro via TransAlta	284 GWh
SaskPower to SaskPower via Manitoba Hydro	693 GWh
Hydro-Québec to Hydro-Québec via Ontario Hydro	20 GWh
Maine generation to Maine load via New Brunswick Power	459 GWh
	1456 GWh

For Commercial Purposes

New Brunswick Power	281 GWh
Ontario Hydro	656 GWh
-	937 GWh

At the present time, then, wheeling is only a very small part; some 3 percent of the total energy transfers. There are indications that this situation may be changing. New initiatives that have been identified, include:

- a March 23, 1990 letter to the Board from Ontario Hydro indicating " . . . we intend to make . . . (wheeling) service more readily available, at least on an interim basis."

- a revision to Québec's energy policy in 1988 which provides for, among other things, "easier trade in electricity in Canada and access to new markets."

- the adoption, in March 1990, of a new B.C. Hydro wheeling policy whereby "B.C. Hydro will offer wheeling service to any party for the purpose of serving load in British Columbia,"[52] including "B.C. hydro will make uninterruptible system capacity available for firm wheeling of energy on a long term basis.[53] (B.C. Hydro is understood to be also developing a policy for interprovincial/international wheeling.)

- the establishment in 1990 of the POWEREX pool operation in British Columbia, which will engage in a number of marketing activities including the exchanging and wheeling of short-term energy.

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[52] BC HYDRO WHEELING POLICY, March 1990.

[53] Ibid.

3. AN ESTIMATE OF BENEFITS OF WHEELING ECONOMY ENERGY

3. AN ESTIMATE OF BENEFITS OF WHEELING ECONOMY ENERGY

3.1 Introduction

This chapter describes a study undertaken by Board staff to estimate certain benefits that would be made available by making use of wheeling services. The results of the study illustrate the importance that wheeling will have within the broader context of enhanced inter-utility cooperation.

Computer simulations were performed on a planning time horizon using real data for power systems connected to form networks to compare alternative operation modes, with and without wheeling. Based on these simulations, the potential benefits made available by wheeling economy energy for each utility involved, as well as the potential benefits for the network as a whole, were determined.

3.2 CANEBEX5 Model

The study described in this chapter was carries out using the Board's CANEBEX5 model[1]. This model is a sophisticated computer program which simulates individual electric system operation and identifies the optimal economy energy transactions among utilities in a network, with and without wheeling. To better understand the results of the studies described herein, a brief description of the model is given below.

For each hour of a study period of up to ten years the model first simulates the operation of each power system in the network being studied and then identifies the optimum economy energy exchanges between the different power systems. In this process, the model performs the following tasks:

- calculates the hourly loads in each system. Hourly loads are adjusted to take into account scheduled inter-system purchases and sales;

- performs economic dispatch for each system. In this process, the possibility of forced outages of generating units in thermal and large hydro plants is taken into account. A Monte Carlo random number generation process is used in deciding whether units suffer a forced outage and in determining the duration of the outage; and

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[1] See Section 3.8 for list of references for this chapter.

- identifies optimal economy transactions between each pair of systems in the network studied, where such transactions are permitted, using an energy brokerage method to match "buy" and "sell" offers according to certain rules[2]. "Buy offers" include the most expensive generating units in service in the network and "sell offers" include the least expensive units available to supply economy energy.

CANEBEX5 requires the generating units in each system to be represented by one or more of the following four types , namely:

- hydro plants which must run every day (referred to as "peaking hydro plants");

- hydro plants with long-term storage (referred to as "large hydro plants");

- pumped storage plants (one per system); and

- thermal plants.

In defining the network for a specific study, the following values must be established for each system's interconnections:

- individual interconnection transfer capacity. Inter-system transfer capacities should include only those lines which interconnect the high-voltage grids of adjacent systems. Transmission lines associated with isolated generation or loads should not be included; and

- total system export limits. This may be the sum of the individual interconnection transfer capacities or a smaller value.

Optimal transactions are obtained under the assumption that hydro and nuclear generation are not displaced by any other type of generation.

Economy energy exchanges between two systems do not take place if the difference between the marginal costs in the two systems is below a minimum value called the incremental cost deadband which is specified by the user.

The economic benefits resulting from economy energy transactions are split between seller and buyer in a ratio specified by the user.

The input data prepared for each power system in the network for the period of the study is described below. The following data were obtained from various publications and correspondence with utilities [4 - 10]:

- hourly loads - calculated from a condensed description of the demand using the IEEE standard load format [3]; peak loads were based on the latest forecasts from the utilities involved. Load shapes were based on information from the utilities or from Board files. The load shapes were adjusted so that the annual energy demand for each system would correspond to NERC forecasts [4];
- scheduled energy exchanges with other systems. All known scheduled transactions were included; and
- power plant and generating unit characteristics. All existing generation plus additions expected during the study period were included.

3.3 Applications

From the beginning of the project it was realized that it would be impractical to attempt to simulate all of the Canadian power systems together with neighbouring U.S. utilities. The approach used was to model a manageable part of the Canadian system and the adjacent American utilities which are their regular trading partners. The results obtained from such studies offer a good indication of the potential wheeling opportunities in Canada. It is planned to extend the present study to other parts of Canada in the future.

It was decided to study the interconnected system of the Northeast Power Coordinating Council (NPCC). A smaller study network, dealing with a part of the network, was used for sensitivity analysis because of the long CPU time for the main study. The main study included all the NPCC systems modelled in some detail, with the exception that an equivalent system had to be used for the Canadian Maritime systems as CANEBEX5 is limited to five power systems.

The utilities or pools which were modelled for the study are as follows:

- In Canada: Hydro-Québec (Québec)
  New Brunswick Power (New Brunswick)
  Nova Scotia Power Corporation (Nova Scotia)
  Maritime Electric Power Company Limited (PEI)
  Ontario Hydro (Ontario)

  Newfoundland was not represented since it does not form part of the interconnected system. However, the Churchill Falls hydro plant, in Labrador, was considered together with the generation in Québec's system. PEI, although not a member of NPCC, was included because it obtains much of it electricity from member systems.

- In the United States: New England Power Pool (New England)
  New York Power Pool (New York)

3.3.1 Procedure for Studies

To identify the benefits of bilateral economy exchanges and the additional benefits which would be made possible by wheeling, a consistent procedure was used in all studies. The steps followed are given below:

1) Simulate the operation of the study network with only prescheduled transactions in place and determine the amount and cost of thermal generation.

2) Repeat Step 1, letting the program identify all the bilateral economy exchanges which can take place, with the resulting benefits, as well as thermal generation and cost.

3) Repeat Step 1, letting the program identify all the bilateral economy exchanges and wheeling arrangements that can take place, with the resulting benefits, as

well as thermal generation and cost. This step was repeated for the various wheeling scenarios studied.

By comparing the results from Steps 1, 2 and 3 the benefits of bilateral economy exchanges and the additional benefits from wheeling were identified.

3.3.2 The NPCC Study

This study identified the potential benefits of wheeling economy energy in NPCC. A schematic of the study network is included in Figure 3.6.

The following three scenarios were examined:

Scenario A -Ontario wheeling:
- to New England through New York, and
- to MARPOOL through New York and New England.

Scenario B -MARPOOL wheeling:
- to New York through New England, and
- to Ontario through New England and New York.

Scenario C - Scenarios (A) and (B) together in addition to:
- New York wheeling to MARPOOL through New England, and
- New England wheeling to Ontario through New York.

In carrying out the process described in Section 3.2 the following five cases were studied:

Case 1 - Only prescheduled transactions between systems;

Case 2 - Optimized bilateral economy transactions on top of Case 1;

Case 3 - Optimized wheeling Scenario "A" on top of Case 2;

Case 4 - Optimized wheeling Scenario "B" on top of Case 2;

Case 5 - Optimized wheeling Scenario "C" on top of Case 2.

The results obtained from these cases are examined in the following section. .

3.3.3 Results

Figure 3.1 illustrates the total network benefit resulting from optimal economy energy exchanges for bilateral exchanges only as well as for different wheeling arrangements. This figure shows that the total network benefits increase by about 6 percent when wheeling takes place. This translates into about $21.0 million for year 1, rising to $40.0 million in year 4 and dropping off to $36.0 million in year 5. The figure also shows that almost all the maximum wheeling benefits attainable from all transactions (Scenario C) are captured with Ontario wheeling (Scenario A).

Figure 3.2 shows the incremental benefits derived from wheeling for the All Transactions scenario. In this study, the wheeling rate was set at 10 percent of avoided cost, paid by the buyer. The figure shows a substantial increase in benefits for Ontario and New England in all years and for New York in years 1, 2 and 3. Small increases in years 1 and 2 for MARPOOL were followed by larger negative values. Québec showed small decreases in all years of the study. These changes are primarily the result of Ontario displacing sales from MARPOOL to New England and also displacing transactions between New York and New England. In addition, wheeled energy from both Ontario and MARPOOL displaces a small amount of Québec's direct sales. These changes in energy transfers are shown in Figure 3.3.

Figures 3.4 and 3.5 show the total energy generated in the network by thermal power plants and its cost in the case where no economy exchanges take place (only scheduled transactions), the case where only bilateral exchanges take place and for the different wheeling arrangements. These values, which are also good indicators of network economic efficiency, show that wheeling reduces the overall amount of thermal generation and the corresponding cost. The figures also indicate that wheeling arrangements do not reduce the thermal generation required beyond the reduction resulting from bilateral exchanges only. The total network thermal generation is reduced by about 16.72 TW.h/year when these economy transactions are permitted. The corresponding decrease in fuel cost is approximately $873 million/year. Furthermore, the total network thermal generation does not change noticeably for different wheeling arrangements. In effect, less expensive thermal generation displaces the more expensive when different wheeling arrangements are allowed.

Figures 3.6 and 3.7 show the total economy energy exchanges in the network for the first year of the study for the cases involving only bilateral economy exchanges and all transactions. Comparison of Figure 3.7(b) with Figure 3.6 shows that wheeling results in greatly increased transfers from New York to New England and a small decrease in transfers from both Hydro-Québec and MARPOOL to New England. They also show that, in the All Transactions scenario, energy from Ontario is wheeled through New York to replace New England generation and displace some purchases from Québec and MARPOOL.

Figures 3.8 and 3.9 show the number of hours in which the transfer capacities of different interfaces in the network restricted possible transactions for bilateral exchanges only and for all transactions respectively. These figures show that the possible economy energy flow on some interfaces was, on average, limited in 6000 hours out of a year. The figures also show that the number of hours in which the interconnection transfer capacities limit economy exchanges increases when wheeling takes place and that the north-south interconnections are the transmission links more prone to producing bottle-necks

3.4 Sensitivity Analysis

In preparing data for the studies described herein, assumptions were made by Board staff regarding the value of some parameters and system operational modes which are normally selected by engineers and operators in the utilities. These assumptions influence and may control the amount of economy exchanges between utilities. To establish the sensitivity of the results obtained to these assumptions, various sensitivity analyses were performed using a smaller system involving only Québec, New Brunswick, Nova Scotia and Prince Edward Island. The study network is shown in Figure 3.10. This study network was used because it required less computing time than the total NPCC network. These analyses included an evaluation of the impacts of the following variables on system benefits as described below.

- the difference between system incremental costs (deadband) below which economy transactions were not permitted; and

- the wheeling rate.

3.4.1 Impact of Incremental Cost Deadband

In the studies carried out, a value of 2 mills/kW.h was selected as the deadband, or the difference between system incremental costs below which no transaction would take place. To determine the sensitivity of the results to this assumption a set of runs was made for the case of Québec wheeling to PEI in which the deadband was varied from 2 to 8 mills/kW.h.

The variation of system and network benefits with the change in deadband is shown in Figure 3.11. The figure indicates that the benefits do not change significantly for values of deadband between 2 and 6 mills/kW.h. However, the benefit decreases significantly for a value of 8 mills/kW.h.

3.4.2 Impact of Wheeling Rates

In the studies carried out, the wheeling rate was set at 10 percent of the avoided cost, paid by the buyer. This value was modified to assess the impact of the rate on the benefits realized.

Figure 3.12 gives the incremental system and network benefits with the wheeling rate set at 10 percent, paid by Québec. The figure shows that, at this wheeling rate, New Brunswick would be better off not to wheel. Figure 3.13 shows the benefits corresponding to a wheeling rate of 20 percent with Québec and PEI each paying half. This figure shows that with this rate, PEI realizes a significant portion of the wheeling benefits whereas both Québec and New Brunswick would be slightly better off than if they had performed bilateral exchanges.

Figures 3.12 and 3.13 show that the choice of wheeling rate affects the distribution of the wheeling benefits significantly. To capture the benefits of wheeling, enough incentive has to be created for all the utilities involved through equitable distribution of benefits. This objective can only be obtained by deriving a suitable wheeling rate based on sensitivity studies similar to those performed here.

3.5 Computer Requirements

The studies described above were performed on a VAX 8200 minicomputer. The main parameters determining the program's CPU time are:

- number of power systems;
- number of thermal and large hydraulic generating units in each power system; and
- the study period.

CPU requirements for the two 5-year simulations, as shown in Table 3.1, were 46 hours for the NPCC study and 14 hours for the runs associated with the sensitivity analysis.

TABLE 3.1

COMPUTER REQUIREMENTS FOR VARIOUS CASES

Study Description	Number of Systems	Total Number of Thermal and Large Hydro Units	CPU Time (h:m:s)
Study 1	5	544	46:34:43
Study 2	4	271	14:02:42

3.6 Conclusions

The results of the studies carried out lead to the following conclusions:

- The total economy exchange benefits for the NPCC system amounted to about $3 billion over the study period of five years. This includes benefits from bilateral exchanges as well as approximately $180 million from wheeling.

- The wheeling benefits varied with the case study and time. However, on average, the studies showed an incremental system benefit from wheeling of about 6 to 10 percent.

- The 6 to 10 percent increase in benefits assumed that all bilateral economy exchanges possible between neighbouring systems had taken place. If, for any reason, full advantage of such exchanges is not taken then the existence of the wheeling option would allow the parties to take advantage of economy exchanges which would otherwise be inaccessible. Therefore, it can be stated that wheeling offers at least an additional 6 to 10 percent benefit and it could make possible benefits from economy exchanges which might be impossible without it. The reasons for not making potential bilateral exchanges could be operational, political, etc.

- The major constraint to economy exchanges in the studies was interconnection transfer capacities. The results show that, in all cases studied, the number of hours that the transfer capacities restricted the economy exchanges increase when wheeling takes place.

- The most suitable value for the deadband within which no economy exchanges are performed seems to be dependent on the study system. It is possible to find a reasonable deadband which reduces the number of transactions and affects the benefits slightly.

- The distribution of wheeling benefits among the utilities involved is an exercise which could be used to create incentives for wheeling. Where wheeling is considered, studies should be performed to identify the most suitable wheeling rates together with the parties responsible for payment so that all the parties benefit from the transactions.

3.7 References

1- N.S. Rau, C. Nesculescu, " A Model for Energy Exchanges in Interconnected Power Systems", IEEE Trans. on Power Systems, Vol. 4, No. 3, August 1989.

2- L. Cohen, "A Spot Market for Electricity - Preliminary Analysis of Florida Energy Broker", Rand Note, February 1982, N-1817-DOE.

3- IEEE Committee Report, "IEEE Reliability Test Systems", IEEE Transactions, Vol. PAS-98, No. 6, Nov/Dec 1979.

4- North American Electric Reliability Council report, "1989 Electricity Supply and Demand".

5- Hydro-Québec Development Plan 1989-1991 .

6- Correspondence with Ontario Hydro, 1987 and 1988.

7- Monserco Limited report "Acid Gas Emissions Derived from the Canadian Utilities Simulation Code for the Province of Ontario", 1989.

8- U.S. Department of Energy's Electric Power Monthly-December 1989

9- Nuclear - New York Power Pool's Electric Power Look Ahead, 1988-2004 dated April 1988.

10- Correspondence with NB Power and Nova Scotia Power Corporation, 1982

Figure 3.1: Network Benefits for Different Wheeling Arrangements.

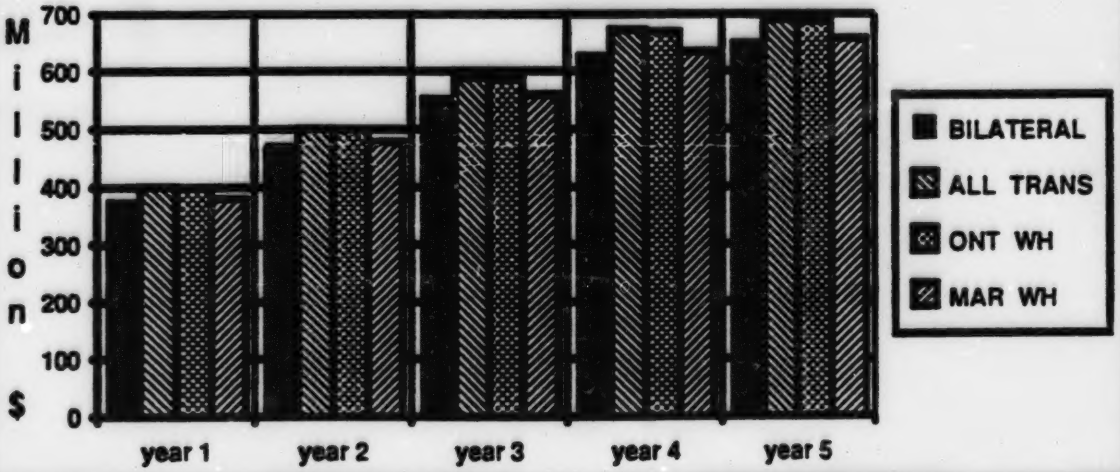
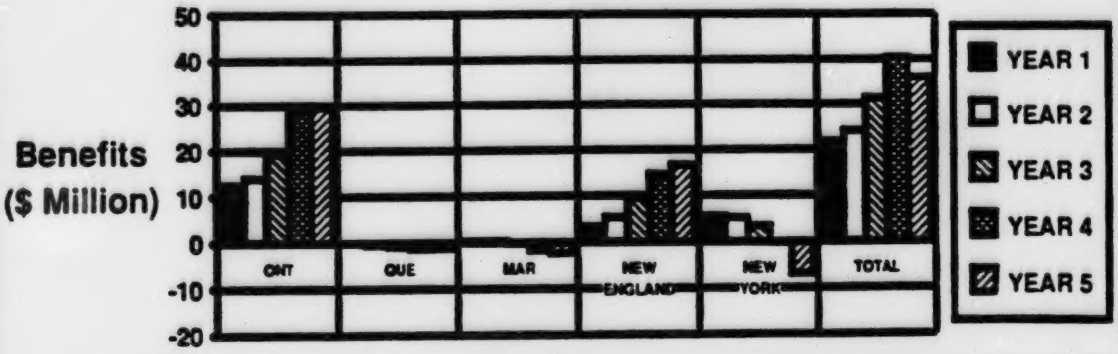


Figure 3.2: Benefits From Wheeling (All Transactions)
WC=10% of Avoided Cost, Paid by Buyer



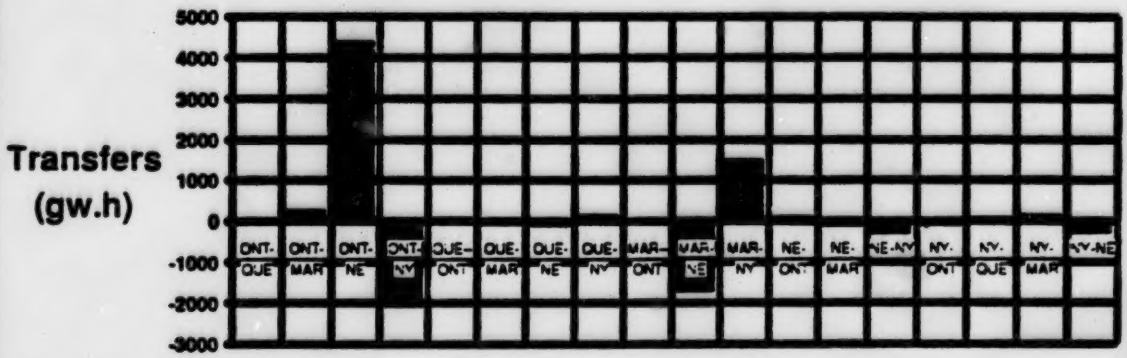
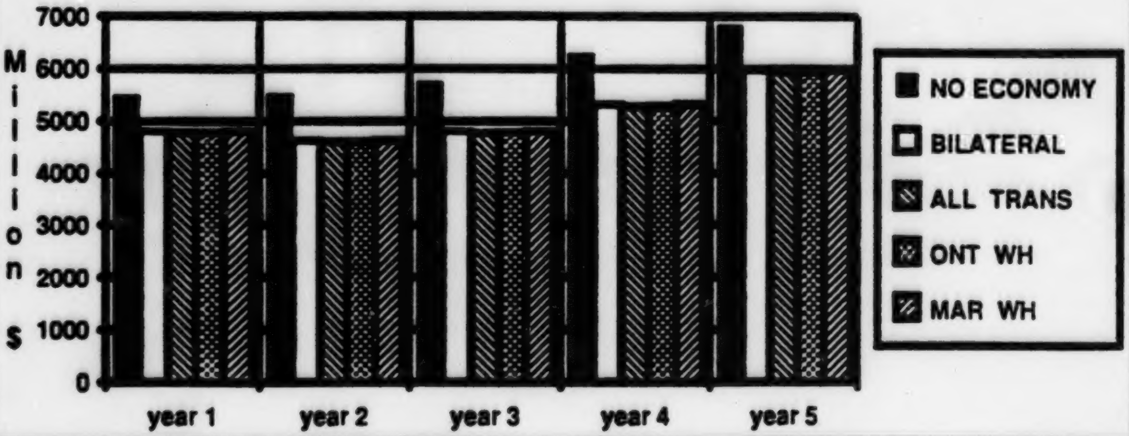


Figure 3.3: Change in Energy Transfers
When Wheeling Permitted
(All Transactions vs. Bilateral Exchanges)

Figure 3.4 : Network Thermal Generation Costs for Different Wheeling Arrangements.



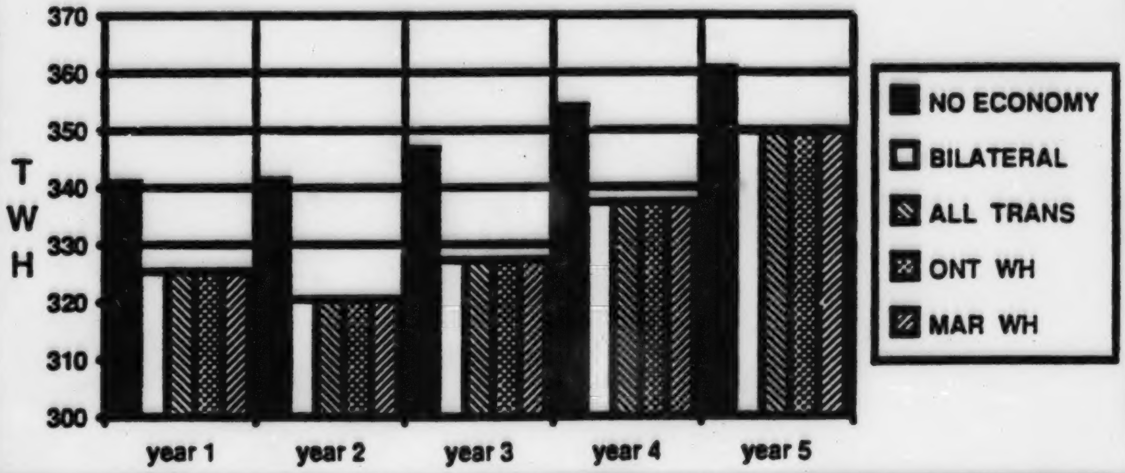


Figure 3.5: Network Thermal Generation for Different Wheeling Arrangements.

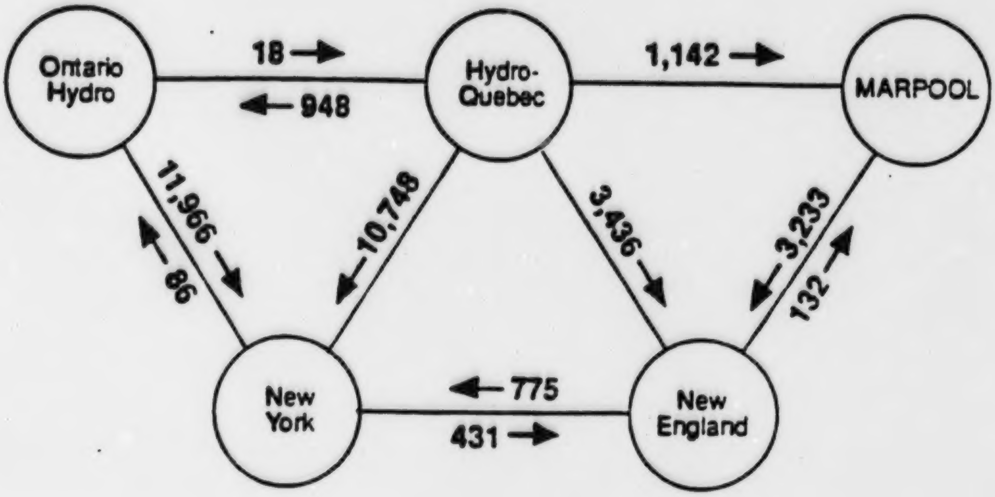
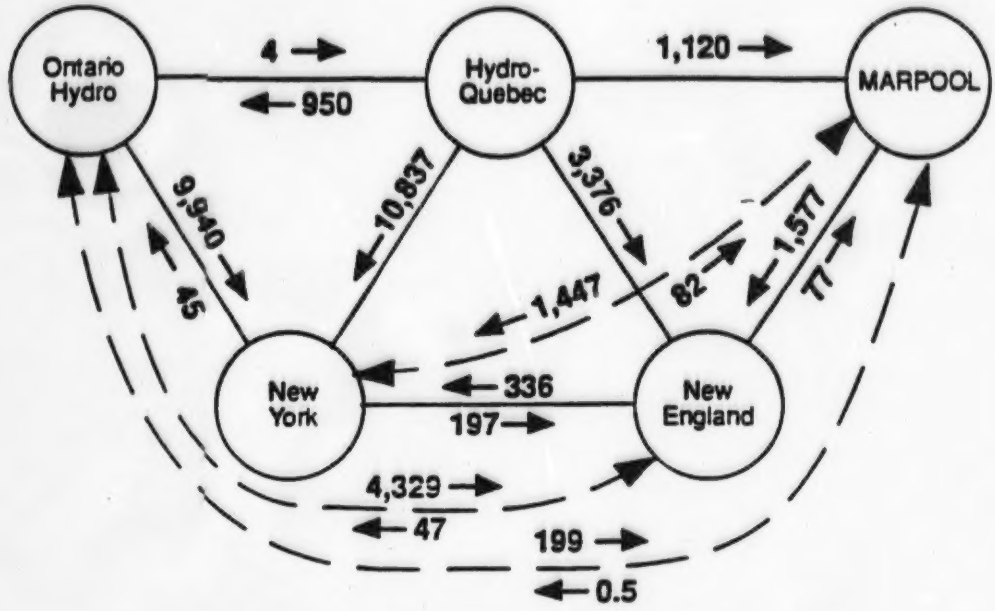
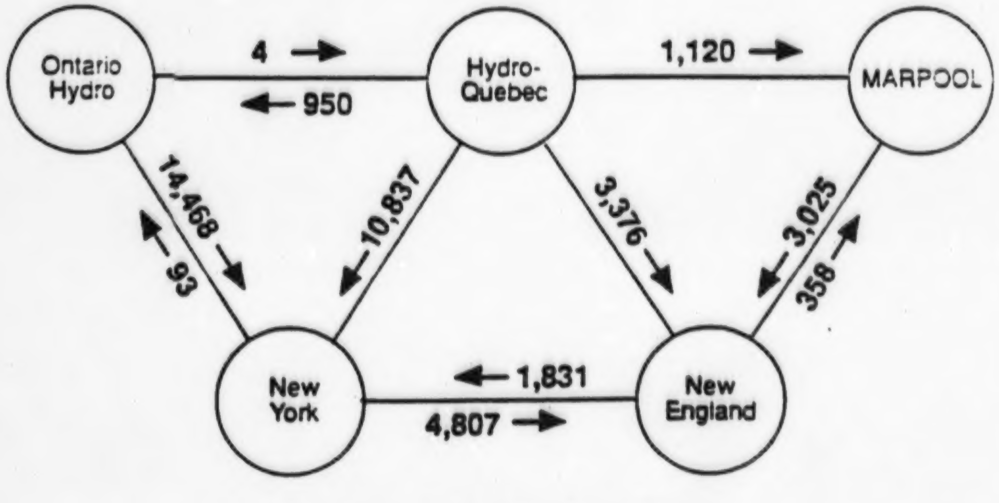

Ontario Hydro
18 →
← 948
Hydro-Quebec
1,142 →
MARPOOL
11,966
← 86
10,748
3,436
3,233
132
New York
← 775
431 →
New England

Figure 3.6 : Annual Economy Energy Exchanges (GW.h)
Year 1990 - Case 2 : Bilateral Exchanges


Ontario Hydro
Hydro-Quebec
MARPOOL
New York
New England
4
950
1,120
9,940
45
10,837
3,376
1,447
82
1,577
77
336
197
4,329
47
199
0.5

a) Annual Economy Energy Exchange


Ontario Hydro
Hydro-Quebec
MARPOOL
New York
New England
4
950
1,120
14,468
93
10,837
3,376
3,025
358
1,831
4,807

b) Resulting Energy Flows

Figure 3.7 : Annual Economy Energy Exchanges (GW.h)
Year 1990 - Case 5 : All Transactions

Figure 3.8: Number of Hours in Which Transfer Capacity Limited Exchanges (Bilateral Exchanges Only)

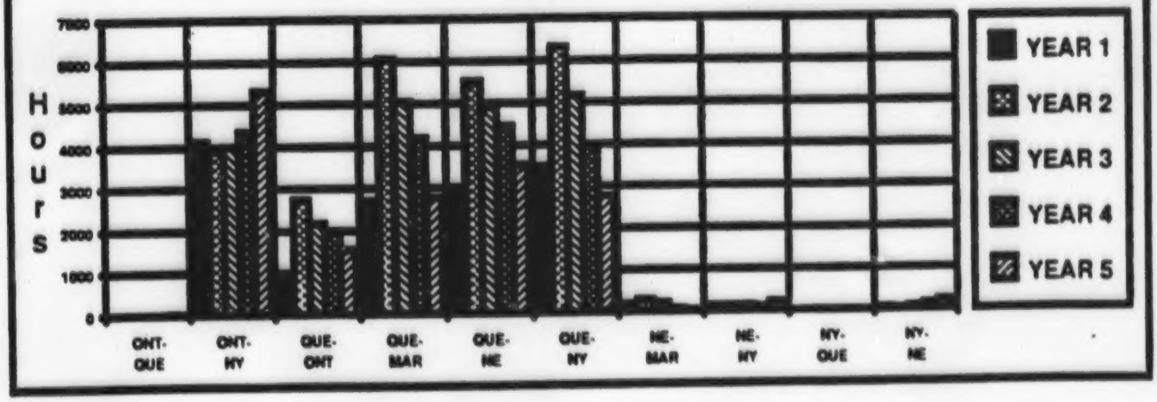
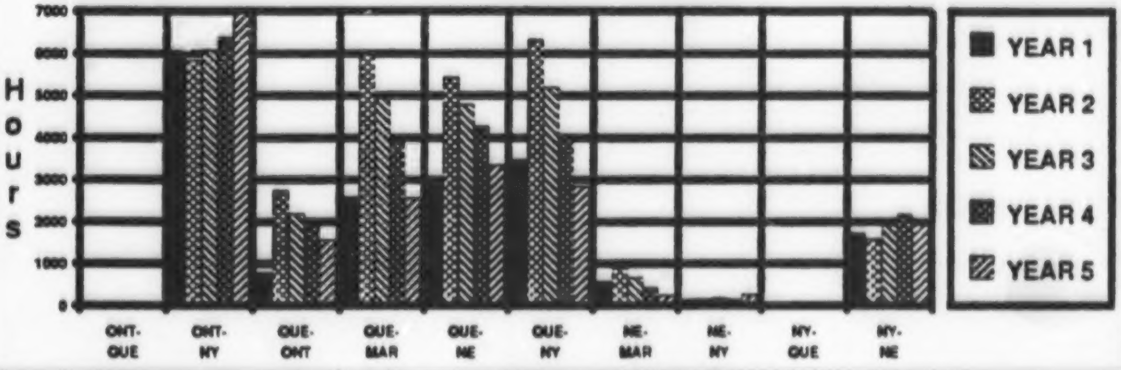


Figure 3.9: Number of Hours in Which Transfer Capacity Limited Exchanges (All Transactions Permitted)



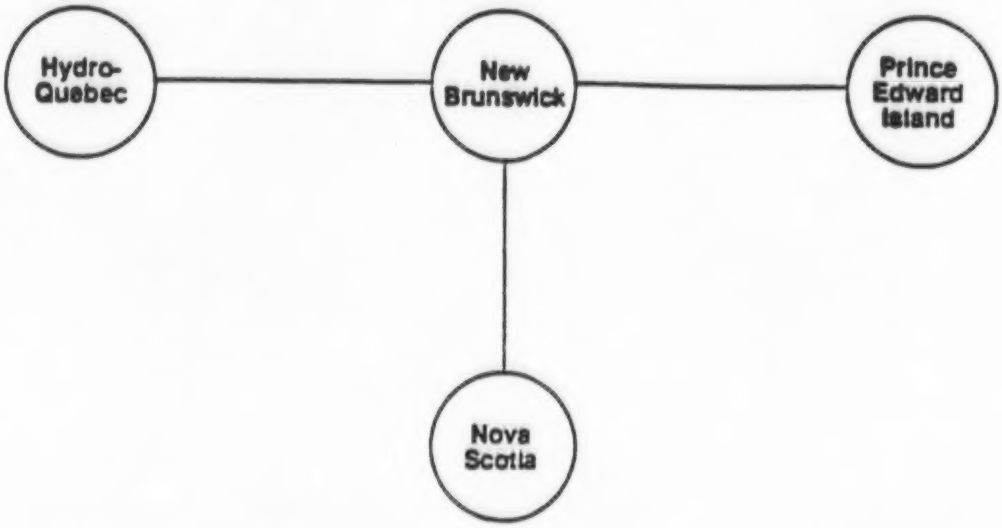

Hydro-Quebec
New Brunswick
Prince Edward Island
Nova Scotia

Figure 3.10 : Study System for Sensitivity Analyses

Figure 3.11: Impact of Deadband on System and Network Benefits

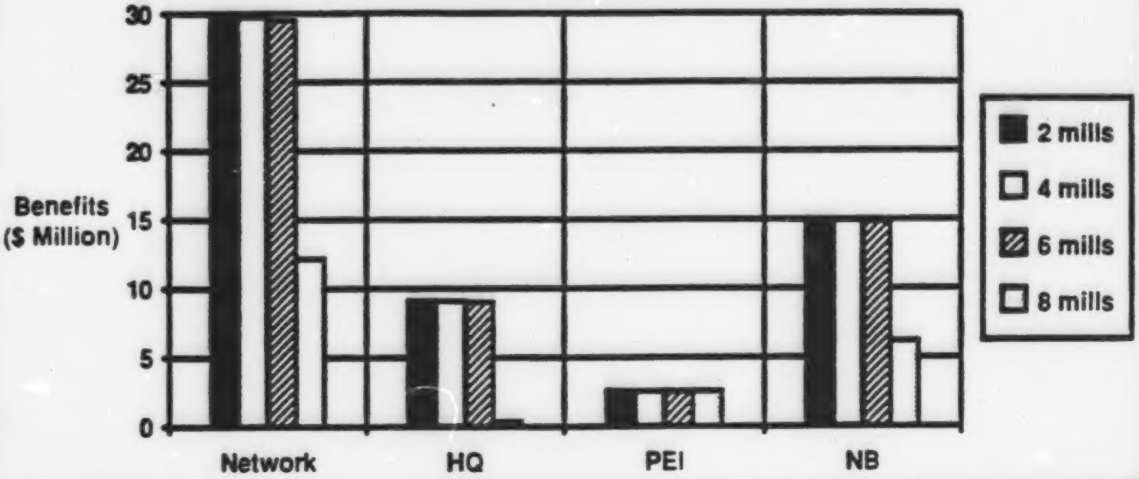


Figure 3.12: Benefits from Wheeling: Que-PEI
WC=10% Avoided Cost Paid by Quebec.

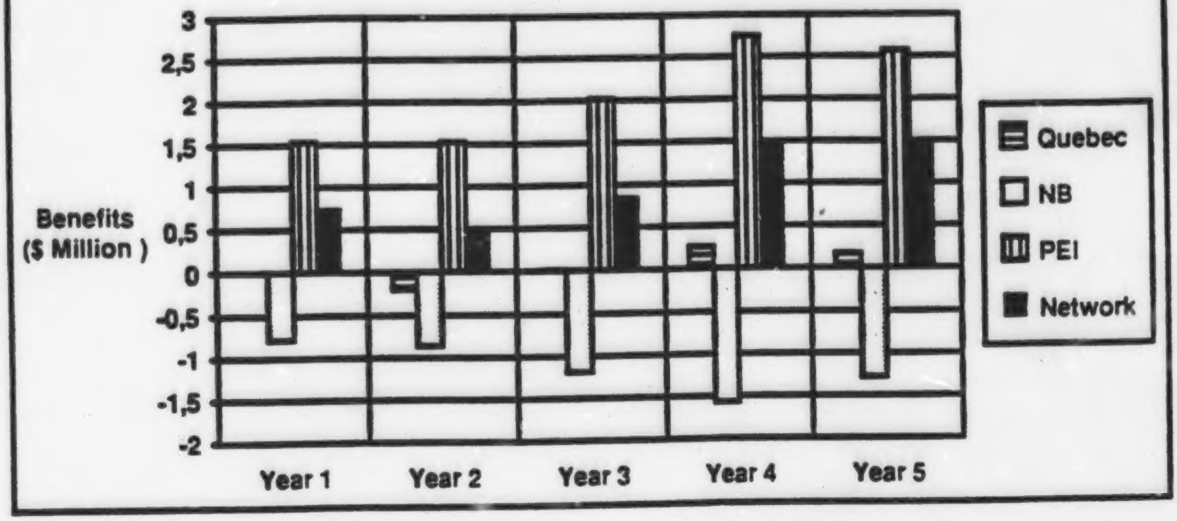
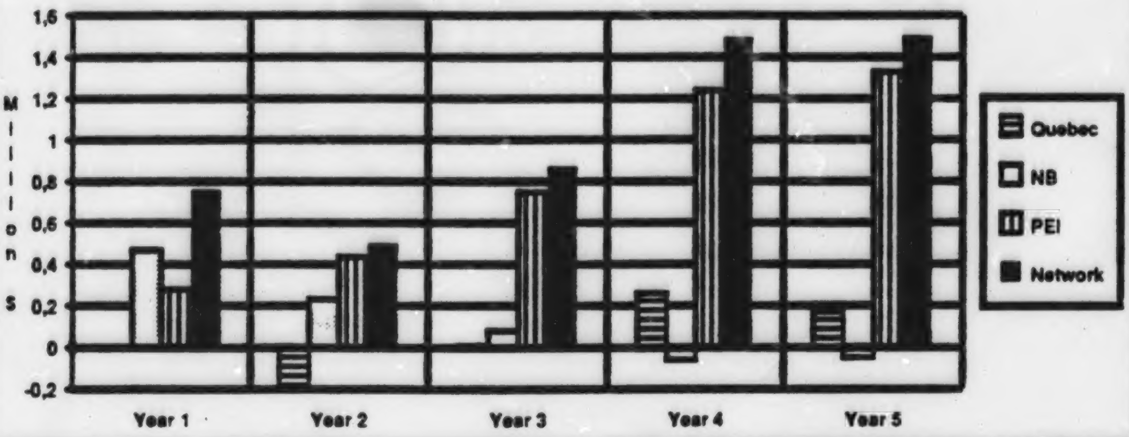


Figure 3.13 : Benefits from Wheeling, WC=20%
Avoided Cost Split Between
Quebec & PEI.



4. POSSIBLE TRANSMISSION ACCESS AND WHEELING POLICIES

4. POSSIBLE TRANSMISSION ACCESS AND WHEELING POLICIES

4.1 Introduction

This chapter draws together the major conclusions from preceding chapters. It describes the various categories of wheeling, suggests a set of principles for establishing good wheeling practices, and outlines a possible transmission access and wheeling policy. Utility responses to this proposal are assessed and, on the basis of this assessment, a set of policy options is suggested for further consideration by interested parties.

4.2 Recapitulation of Study Results

It is clear from other chapters of this report that there are significant quantifiable benefits to wheeling, as well as many approaches to the subject of opening up access to transmission facilities, both existing and proposed. Opinions are varied and conflicting as to whether wheeling should be mandated or voluntary, and how such services should be priced.

In large measure, the inability to reach a consensus on the matter of wheeling in general is rooted in the nature of the service itself since each wheeling activity is highly specific in terms of the circumstances under which it is to be performed. What can be accomplished physically in one situation bears no relationship to any other arrangement. In the simplest situation, a particular utility might be able to wheel a specific quantity of power through its system from a particular supplier to a particular purchaser at particular times. But, any increase in the amount of power, any change in the parties involved (i.e., change in path), or any change in the times (hours, days or seasons) at which the power is to be wheeled might not be achievable physically, or might require costly upgrades and facility additions.

Just as complex is the matter of pricing the wheeling service. Should pricing be based on the costs of providing the service or on the benefits achieved? If the pricing is to be cost-based, how should these costs be measured - on an embedded or incremental basis? What if a system has to change its operations and forgo savings to provide the service? If pricing is to be related to the benefits realized, what is a reasonable way of sharing the benefits among the parties involved? If circulating power flows result from the wheeling transaction, how are the other utilities affected to be compensated?

It is not surprising, therefore, that in view of these (and other) dimensions associated with the subject of wheeling, commentators and analysts of the problem can do no more than propose a few very general principles for guidance, and that there is no consensus on these principles.

Although the utilities in both Canada and U.S. have achieved great success in providing a secure, efficient supply of electric power, the analysis performed as part of this review indicates that there is potential for additional benefits from wheeling. However, care must be taken to ensure that modifications to transmission policy in Canada lead to an increase in net economic benefits and not simply to a reallocation of these benefits.

Electricity is a unique product and the transmission of electricity is different from the delivery systems associated with other products. Therefore, any programs or proposals with respect to electric power systems must be measured within that context alone, and not compared with other types of systems.

Decisions relative to the future structure of the electricity supply industry must also be made in the context of appropriate future circumstances. At least some of the current pressures for more extensive wheeling arrangements are attributable to the existence of excess generating capacity and large differentials in fuel costs that occurred in the recent past. It is generally expected that, in the future, a shortage of generation will become a problem, as will increased transmission bottlenecks and increasing difficulty in obtaining additional generation sites and transmission rights-of-way in both Canada and the U.S. The interconnected transmission systems of North America will become even more valuable resources that must be used wisely in the public interest.

The potential economic benefits from broad transmission access should be evaluated over a long time period. How Canadian transmission systems are used will determine how they are planned and what new lines and new facilities are added. The effects of any transmission access and wheeling policy will be long-lasting and not easily reversed. Such a policy should be developed with great care.[1]

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[1] In the U.S., a generic approach was proposed that did not reflect power system operational and planning requirements. The result was strong opposition from most of the utility industry. The U.S. is now proceeding on a step-by-step, case-by-case evolutionary approach.

As discussed earlier, practically all electric utilities in Canada and the U.S. are interconnected with others, forming five vast electrical networks that cross international, provincial and state boundaries. These interconnections are the result of two-thirds of a century of continuous activities and technological improvements to realize increased reliability and economy. Large benefits to the users of electricity result from the high level of coordination that has been reached through the cooperative efforts of all forms of utilities, and regulatory and other governmental agencies. Increased transmission access and wheeling activities, as well as other changes in the electricity supply industry, should be developed within the same atmosphere of cooperative effort. Any other approach might indeed lead to increased wheeling, but this might be obtained at the expense of the economic and reliability benefits already achieved, with consequent negative impacts on electricity consumers.

In the sections which follow describing the general concepts that should govern wheeling and proposing guidelines for a transmission access and wheeling policy in Canada, the subject is addressed as a separate and additional service that utilities would offer beyond their primary activity of supplying reliable and low-cost electricity to their customers. This service would include interconnection and the coordination of operations and planning with their neighbours, economy energy interchanges, participation in reliability councils, etc.

4.3 Categories of Wheeling

Although transmission access and wheeling services have no intrinsic value, they can be essential elements in permitting the use of least-cost generating resources over wider geographic areas. The wheeling of electricity across transmission grids falls into three basic categories which are referred to here as "system wheeling", "supply wheeling" and "retail wheeling".

Retail wheeling services would be necessary when a generator wished to supply a particular customer not located in the generator's franchise area, and to which it was not directly interconnected. In general, Canadian utilities have mandates from their respective provinces to supply loads within their franchise areas. The direct sale of power from generators to customers would require a radical restructuring of the electricity supply industry, particularly in re-defining the mandates of the utilities. This is a provincial matter and would not involve the federal government directly. Also, it would not involve inter-utility cooperation and, as such, is not within the scope of this assessment. Therefore, retail wheeling was not considered in the current study.

The following paragraphs describe system wheeling and supply wheeling, and provide examples of the types of transactions that can depend on them.

System Wheeling

It is quite normal for a utility to find itself in a surplus condition and, hence, is able to sell power to a second utility that is either in deficit or whose marginal cost of supply is greater than that of the first. When the two utilities are not directly interconnected, the sale and purchase of the surplus power involves wheeling through an intermediate utility's transmission network. This type of wheeling is categorized here as "system wheeling".

Typically, system wheeling is carried out only on a utility-to-utility basis and does not involve non-utility generators. It is used by utilities to extend the geographical area over which they can clear their short-run and persistent long-run surpluses.

Examples of short-run transactions requiring system wheeling are daily, seasonal and annual sales and exchanges of temporary surpluses of capacity and economy energy; and energy sales from a predominantly hydroelectric utility during years of high water conditions. Short-run system wheeling usually does not depend on the development of new generation or bulk transmission facilities built specifically to support this type of transaction. However, where transmission bottlenecks prevent such activities, some relatively minor strengthening of transmission networks may be necessary.

As shown in Chapter 3, an estimate was made using the CANEBEX5 model of the short-term benefits that would result from increased economy energy transfers, including bilateral exchanges and wheeling among non-adjacent systems, in eastern Canada and the northeastern United States (Ontario, Québec, the Maritimes, New York and New England). The total value of bilateral exchanges available in this region over a five-year period was estimated to be some $3 billion, expressed in 1990 purchasing power. By allowing access to system wheeling services, these benefits were estimated to increase by up to 10 percent. Opportunities for similar short-term energy transfers requiring system wheeling are likely to exist in other regions.

Examples of requirements for long-run system wheeling are instances where seasonal diversity exchanges between winter and summer peaking systems require transmission service of intermediary parties; where a predominantly thermal utility wishes to sell off-peak surplus energy; and where a predominantly hydro utility has seasonal energy surpluses to sell. Long-run system wheeling does not involve the development of new generation but may necessitate the construction of additional bulk-transmission facilities.

In the parallel study of Inter-utility Cooperation, estimates were made of the additional long-run benefits that would be available from enhanced cooperation. The realization of some of these benefits, including certain seasonal diversity exchanges and/or firm summer sales, would involve system wheeling.

Supply Wheeling

In the long-run, as its native load grows, a utility can be faced with the choice of either building a new generating unit itself, or entering into a contract to purchase equivalent power from another utility or from a non-utility generator. When the cost of the purchase is less than the utility's own long-run marginal cost of supply, it may wish to purchase rather than build. However, when the utility is not directly interconnected to the potential supplier, a long-term arrangement has to be made with an intermediate utility to wheel the power. The transaction may also involve the construction of a bulk transmission line to deliver the power or major additions to existing transmission networks, at least during part of the contract period. Here, this type of wheeling is termed "supply wheeling".

The ability to gain long-term access to wheeling services permits a utility to expand the geographical area from which it can seek new generation sources to meet load growth in its own service area. Competitive bidding for generation can take place on a regional basis. The new generating sources can be owned by either utilities or non-utility generators, including independent power producers.

Estimates were made in the parallel study of Inter-utility Cooperation of the net benefits that might be available from long-term firm sales of electricity. Some of the transactions identified in that study would require supply wheeling.

4.4 General Principles

There are two overriding and general principles which define the conditions necessary for the successful establishment of a cooperative atmosphere for wheeling to take place. These principles are:

1. **The public interest is best served when least-cost generating resources are used to the maximum possible extent, without regard to ownership of the resources or their locations in regard to loads.**

2. **Compensation to the utility providing wheeling services should include reimbursement of the associated direct costs (including any benefits forgone in their own internal operations resulting from the service) plus a reasonable share of the net savings.**

Principle 2 relates mainly to the clearing of short-term surplus from utility systems and not to long-term firm sales of wholesale electricity.

These general principles require subsidiary principles to define mechanisms for developing wheeling arrangements on a voluntary basis which is believed to be the only workable approach to the process.[2]

4.4.1 Principles Governing the Availability of Wheeling

Utilities have the responsibility of providing reliable, low-cost electricity to consumers within their service territory. They have an obligation to serve every potential consumer. They are held accountable for the quality of service to their customers. They have designed power systems for the specific function of serving their franchise territories. Practically all utilities have interconnected voluntarily with their neighbours for the primary purpose of benefiting their customers through improved reliability and economy.

From the foregoing, the following three principles bearing on wheeling have been derived. If the utilities are to be held accountable for the quality of service to their customers, then

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[2] Comments by J.A. Casazza and A.J. Schultz to FERC in response to Notice of Proposed Rule Making, July 1988.

3. **Utilities must make the ultimate decisions on the use of their own systems and facilities.**

The wheeling utility must be the final judge as to the physical capability of its system to accommodate the requested wheeling service and the need for and the nature of upgrades, etc. If any other agencies are to decide and to mandate how a utility's transmission facilities are to be used, who will use them, and when facility upgrades or expansions are needed, those other agencies must also be held accountable for the consequences of their decisions, not the utility.

Further, a utility's system having been conceived and built to serve its native customers who, in turn, assure payment of the investment-related costs of the facilities, it follows that:

4. **The reliability of service to a utility's native customers is not to be affected detrimentally by the wheeling of power through its transmission system.**

A utility in accepting a wheeling transaction must do so under conditions that do not degrade service to its own customers. It is recognized that in some region-wide coordination groups and power pools, all members have agreed to provide support to any utility experiencing an emergency, even to the extent of curtailing service to their own customers on a proportional and reciprocal basis. It is believed that mutual support arrangements of this type do not violate the stated principle since they enhance the overall economy of providing reliable service to the customers of all participating utilities.

Because of its participation in large regional networks through its interconnections with other systems, and because of the many economic and reliability benefits being achieved through coordination with neighbouring systems, the wheeling utility:

5. **must plan, design and operate its system, including the provision of wheeling services, so that it meets its regional and interregional obligations at all times.**[3]

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[3] ELECTRICITY TRANSFERS AND RELIABILITY, NERC, October 1989.

4.4.2 Principles Relating to Pricing for Wheeling

The principles which should guide the pricing for wheeling services should be predicated upon the same factors as those stated above. Restated, a utility has an obligation to serve its native customers, and has created an electrical system and made commitments in order to fulfil this responsibility. The customers, through their payments, provide financial support for these commitments and for the risks undertaken by the owners of the utility.

In undertaking to provide wheeling services, a utility is, by definition, providing services for the benefit of other utilities and their customers. Therefore the wheeling utility and its customers should benefit from the wheeling transaction. It follows that the wheeling utility's incremental cost of providing the service is the lower limit, or floor, for pricing the wheeling service. Any price that recovers more than the incremental cost of the wheeling transaction benefits the native customers.

It is also true that a service cannot be sold at a price higher than its value. However, wheeling services can be provided in a large spectrum of conditions of priority, with an equally large range of values to the purchaser.

Recognition of these circumstances suggests that:

6. **Utilities providing transmission services should have the flexibility to relate their prices to the specific conditions of the service provided and to the benefits achieved, through negotiations with the entity requesting the wheeling.**

7. **Utilities should expect to earn a normal rate of return, commensurate with the risks involved, on their investments in all new transmission facilities, when these are economically justified, without harming their customers.**

Regarding Principle 6, the computation and justification for the various elements making up the rate charged for a particular wheeling service should be made available to the party requesting the wheeling.

The application of these principles most probably will lead to prices that vary from time to time. For example, the wheeling service may require facilities to be installed in advance of the time they would otherwise be required. Therefore the service should support all of the associated costs until the facilities become necessary to serve the native customers, at which time a reallocation of costs will lead to a reduction in the price for firm wheeling services.

In considering the conditions under which a utility will provide and price wheeling services, it will examine other opportunities which may be lost or prevented as a consequence. Loss of opportunity for interruptible sales due to wheeling of firm power should be accounted for in the charge made for wheeling of firm power. However, the possible loss by the wheeling utility of a potential future power sale is an issue still to be resolved.

There are two kinds of lost opportunities that might result from wheeling:

- those due to changes in operations required to accommodate the wheeling or due to transmission congestion (i.e., because of insufficient transmission capacity, the wheeling arrangement and the alternative opportunity cannot both be accommodated)[4]

- those due to loss of power supply or markets (i.e., the party purchasing the wheeling is able to outbid the wheeling party for resources or markets previously not reachable)

In the first instance, wheeling imposes changed operations and/or lost sales. Since the wheeling utility has an obligation to act for the benefit of its customers, the price for wheeling should recognize the value of alternative but foreclosed benefits. The benefit that is lost as a result of allowing a wheeling transaction is a cost to the wheeling utility and should be included as part of the incremental costs associated with the transaction.

The second situation is more complex. Assume a utility with relatively low-cost power resources which are excess to the needs of its own customers and for which it has no market. Assume further that a neighbouring utility is supplying an external market (i.e., other than native load) with higher-cost resources. The first utility wishes to use the second utility's transmission system in order to sell in the bulk market where it would displace the second utility's sales.

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[4] This was a major issue in a recent lawsuit alleging that Southern California Edison Company engaged in anti-competitive activities relative to the use of the Pacific Northwest-California Intertie.

If, in this example, there is an increase in the overall net benefits, the two utilities could both benefit from working together. The utility that supplied the market prior to the wheeling arrangement could receive a somewhat improved benefit and the utility which takes over the market could receive the remaining share of the benefit whereas, prior to wheeling, it received no benefit at all. The second utility might not be satisfied with this share of the net benefits, but in reality the lost opportunity costs to the first utility add substantially to the costs of the transmission alone. Any other approach, however, would cause the first utility to be worse off than it would be without the wheeling arrangement.

Suppose under the same situation, however, that the market to be considered is an enlargement of the existing market or a new market (i.e. one not previously supplied by either utility). If the utility adjacent to the market wheels for the remote utility, it will not be able to compete for the new market. By providing wheeling, it effectively abandons a beneficial market it might otherwise have had. If the wheeling utility provides transmission service, can it reasonably claim lost opportunity costs for a potential situation? Should it be forced by government action to prevent it from exercising its market power under these circumstances?

Decisions on this last issue involve substantial public policy considerations which are beyond the scope of this investigation. This matter will be left as a question.

The pricing principles must also reflect the fact that other interconnected utilities may be affected by the transaction because of parallel path flows. Parallel path flows defy generalizations. For situations involving firm power wheeling in which there may be substantial parallel path power flows (in excess of 25 percent of the power to be transmitted), it is suggested that:

8. **The wheeling utility must have in its system sufficient transmission capacity to provide the wheeling service with the assumption that the power were actually to flow through its system.**

9. **If some of the power to be wheeled actually flows through the systems of utilities which are not part of the transaction, such utilities should be compensated at negotiated amounts.**

Compensation for parallel path flows can be in cash or in kind. Payment in kind is likely to occur when the wheeling imposes no burden or restraint on the utility affected by parallel path flows. That is, a utility, may allow parallel path flows on its system in return for the wheeling utility accepting, on a reciprocal basis, parallel path flows on its system.

If there are substantial parallel path flows for which cash compensation is to be paid, that compensation should be paid by the wheeling party. The price to the party purchasing the wheeling should not be increased because of parallel path flows.

4.4.3 Implementation of the Principles

The generalized nature of the principles stated above obviously can lead to a variety of interpretations. There are bound to be controversies simply because many considerations in utility operations are subjective.

Recognizing that differences of opinion with respect to pricing of wheeling services have arisen and will continue to arise, even if there is agreement on the principles to be implemented, the only possible solutions are: (1) through negotiation among the parties involved; or (2) through the intervention of some outside party with the necessary authority.

In the first instance, negotiations among the parties would appear to be the most effective means of resolving any controversy relating to wheeling services. Within the pricing confines of principles 2, 6, and 7 stated above, the differences separating the parties would be those of measurement or definition, which are amenable to negotiation.

Principle 9 requires that a utility affected by parallel path flows be a party to the negotiations. The determination of when an interconnected utility is affected is a difficult matter. If that utility operates close to its internal transfer limit, a relatively small amount of additional power from the wheeling transaction could cause a problem. On the other hand, as a mathematical proposition, any wheeling transaction causes some calculable change in every utility that is part of the interconnection. Some threshold, as a fraction of the power to be wheeled or as a quantity of power, below which parallel path flows can be ignored seems appropriate. The suggestion that parallel power flows, up to 25 percent of the power to be wheeled, be ignored is predicated on the assumption that the wheeling utility has sufficient capacity to provide the services and that it would accept on a reciprocal basis the equivalent amount of parallel path flows over its own system.

4.5 Initial Proposal for Wheeling in the Canadian Context

4.5.1 Introduction

In undertaking to suggest guidelines for the use of electrical transmission systems in Canada, the Board is mindful of the recent work of the Energy Options Advisory Committee. The report of this group provides a description of the Canadian milieu for energy within which the wheeling process must be contained.

> "Canadians believe that regions and people should share their prosperity, including their energy wealth." (p. 2)[5]
>
> "We have a heritage of constructive compromise and social conciliation and a fundamental respect for the rights of the individual." (p. 2)
>
> "There is a need for a policy approach which eliminates artificial barriers to interprovincial trade in energy ..." (p. 5)
>
> "Participants generally argued for some variant of market-based pricing as the best indicator of market value in most circumstances. Where this is not feasible, as in the pricing of electricity, there was general agreement that prices should be as close as possible to those that would prevail in competitive markets." (p. 6)
>
> "Participants agreed that governments should intervene in the allocative process only to correct serious market imperfections or failures." (p. 6)

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[5] Energy and Canadians: Into the 21st Century - A report on the Energy Options Process, 1988

> "...there was unanimity that energy policy requires a much greater degree of federal-provincial cooperation and harmony than that which characterized the 1970s and early 1980s." (p. 7)

Taking into consideration both the broad principles for wheeling discussed earlier and the above characterizations of Canadian requirements, it is proposed that the specifics of any wheeling arrangement are best left to negotiations among the participating parties. It is also recognized that there are many elements involved in defining particular wheeling transactions which are ambiguous in nature and about which there can be differences of opinion. Furthermore, negotiations are not always successful.

If negotiations fail, it is suggested that consideration be given to arbitration. Under arbitration, determinations are placed in the hands of independent, qualified individuals who have the training and experience to understand the technical problems. The arbiters are equipped to arrive expeditiously at workable solutions that are applicable to the specific situation. If arbitration is to resolve issues in conflict, the parties have to agree in advance to be bound by the process.

If arbitration is not the mechanism to be followed, the only other avenue is for action by a government agency having authority. In the U.S., the FERC has the authority to respond to an application for wheeling pursuant to the statutory provisions discussed in Chapter 2. Beyond that, it is possible that the anti-trust laws might have applicability in some instances. In Canada, no federal agency exists with legislative authority similar to FERC.

4.5.2 Specific Elements of the Initial Proposed Wheeling Policy

From the preceding discussion, a wheeling policy is proposed which contains the following four elements:

- **The Process** - for making wheeling arrangements;
- **The Economic Principle** - on which the charge for the service is to be based;
- **The Contract** - under which wheeling will be carried out; and
- **The Effect on Reliability** - of the proposed wheeling transactions.

Each of these elements is discussed below.

The Process

The suggested process for arranging wheeling transactions is as follows:

i) Voluntary Negotiation

To the extent possible, wheeling arrangements are best secured through voluntary negotiations carried out in good faith among the utilities involved.

ii) Binding Arbitration

In those instances where utilities cannot reach agreement through voluntary negotiations, either party may request binding arbitration to resolve their differences. If both parties agree in advance to binding arbitration, they may follow one of two procedures:

a) work out their own arrangements to obtain a panel of arbitrators; or

b) request the federal government to nominate a panel of arbitrators who are qualified persons with experience in utility planning and operations.

iii) Mandated Solution

Finally, if the parties can neither negotiate an agreement nor agree to binding arbitration, then either of the parties involved should be able to seek redress before a federal agency with the authority to mandate a solution. The existence of a federal agency with the requisite authority to mandate a solution if negotiations fail could expedite the negotiation process and assure that no party negotiated with less than good faith. The agency would exercise its authority only after one party certified that the negotiation process had reached an impasse, that arrangements for binding arbitration could not be established, and certified as to the magnitude of the economic benefits that would be lost in the absence of the proposed wheeling.

The Economic Principle

It is clear that there are many types of wheeling services that utilities can provide. Pricing for these services should be based on the principles outlined previously. Although no single formula can be applied to all wheeling situations there is one overriding pricing concept that should apply. It is that pricing should reflect market-related factors (i.e., the revenues and costs of the power/energy transactions) as well as the incremental costs of transmission. Identification and quantification of all relevant costs and benefits form the best basis for good faith negotiations among the participants. In the final analysis wheeling can only succeed if all the parties involved benefit from the transaction.

The Contract

Electricity wheeled by utilities over interconnected transmission systems follows paths determined by the laws of physics and not arbitrarily defined contract paths. Consequently, paired buy/sell transactions which consider only system-to-system transfers of electricity and where prices for wheeling services reflect market-related factors are to be preferred to those wheeling arrangements which would require the identification of specific transmission paths or facilities.

Such paired buy/sell transactions may be set up when the intermediate party is in a position to buy the energy at a price between the seller's cost and the buyer's value. In these transactions, the intermediate party would collect a share of the difference in price between the buyer and the seller that may substitute for, or provide more revenue than, direct wheeling charges.

The Effect on Reliability

Utilities are responsible for providing reliable electricity service to their native load customers and are generally governed by the planning and operating criteria of the regional reliability councils to which they belong. Therefore, the wheeling of electricity should not reduce or impair the reliability of service to native customers. To ensure that this principle is respected, utilities should remain responsible for the design, operation and planning of their systems and facilities, including the provision of wheeling services, so that they meet their regional and interregional obligations at all times.

4.6 Reaction to the Proposed Policy

Canadian utilities and the provinces, as represented by the provincial energy departments, were provided an opportunity to examine and comment on the initial proposed wheeling policy which was presented in a draft report prepared by the Board, and their responses to the proposed policy are summarized in Table 4.1.

Examination of the responses by the utilities and the provinces leads to the following observations:

Process

In respect of the process, there appeared to be unanimous support for the principle that wheeling arrangements should be secured through voluntary negotiations among the parties involved. There was also some support for the development of wheeling policies by utilities which would help to establish appropriate arrangements for future wheeling transactions. Generally speaking, those utilities which have direct access to export markets and are also interconnected interprovincially supported the premise that, if voluntary negotiations fail, there should be no recourse to further procedures. In effect, they favoured maintenance of the status quo.

On the other hand, those utilities with no direct access to export markets appeared to favour the principle that some form of binding arbitration and/or federally mandated solution would be necessary to secure an agreement if negotiations were to fail.

Economic

There seemed to be near unanimous agreement that wheeling services should be priced to reflect market-related factors. The sole exception was Newfoundland and Labrador Hydro which appeared to favour embedded-cost pricing for wheeling services.

Contract

Most utilities did not comment on the preferred contractual arrangement suggested in the initial wheeling policy proposal which was that paired buy/sell arrangements are

Table 4.1: Summary of Responses from Utilities and Provincial Departments of Energy

Utility	Process			Economic	Contract	Reliability
	Voluntary	Binding Arbitration	Mandated			
Nfld. Hydro	Yes	Yes	Yes	No	-	Yes
Nfld. Light & Power	Yes	No	Yes	Yes	-	Yes
NB Power	Yes	No	No	Yes	-	Yes
Nova ScotiaNS Power	Yes	Yes	No	Yes	-	Yes
Maritime Electric	Yes	Yes	Yes	Yes	Yes	Yes
DoE&F, PEI	Yes	Yes	Yes	Yes	-	Yes
Hydro-Québec	Yes	No	-	Yes	No	Yes
Québec Min of Energy	Yes	-	-	Yes	-	-
Ont. Hydro	Yes	-	No	Yes	-	Yes
Ont. Min. of Energy	Yes	-	Yes	Yes	-	-
Man. Hydro	Yes	-	-	Yes	-	Yes
SaskPower	Yes	-	-	Yes	-	Yes
TransAlta	Yes	Yes	Yes	Yes	-	Yes
BC Hydro	Yes	No	No	Yes	No	Yes
West Kootenay	-	-	-	-	-	-

preferable to arrangements involving a "contract path" approach. This low response may be attributed to the fact that currently there is little wheeling among Canadian utilities and, therefore, actual experience in arranging contracts is limited.

Reliability

There appeared to be a consensus that wheeling should not degrade the reliability of service to native customer loads since the wheeler is ultimately responsible for providing this service. However, some utilities tempered their support by cautioning that reliability should not be used as a pretext to refuse wheeling. Others stated that there would be a serious dichotomy if the responsibility for reliability remains with the wheeling utility under a mandated wheeling option.

4.7 Prospects for Wheeling

It is clear that transmission access and wheeling are issues that cannot be addressed on their own but form part of the larger question of how utilities might cooperate with each other to increase and enhance interprovincial and international trade (refer to the Board paper on Inter-utility Cooperation).

Within the framework of the regional development entities described in the above-noted paper and displayed in Figure 4.1, which shows interconnection transfer capabilities in MW, and considering the responses by utilities and the provinces to the suggested transmission access policy, the following illustrative observations on the prospects for wheeling have been compiled.

Region 1

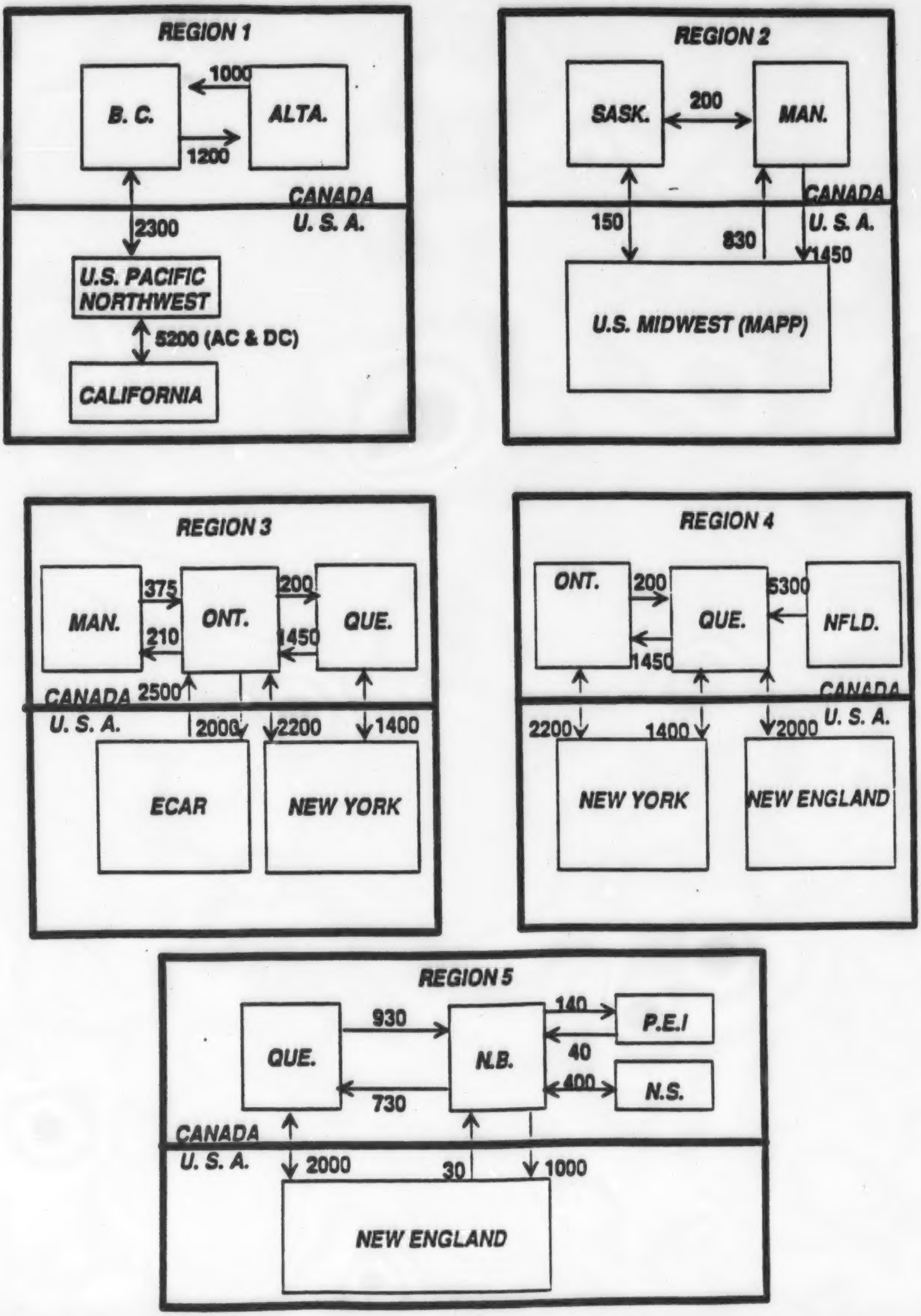
Both B.C. Hydro and TransAlta Utilities appear to consider that wheeling arrangements can be secured voluntarily and that the pricing of wheeling services should be based on market-related factors. TransAlta, however, would like to see an arbitration process backed by the opportunity for federally-mandated wheeling if negotiations fail. It is noted that B.C. Hydro has already established a wheeling policy which allows interconnected utilities, as well as IPPs to arrange for such services. Although B.C. Hydro and TransAlta disagree on the process and have been unable to conclude a true wheeling arrangement, it is understood that negotiations have taken place and buy/sell deals are being struck. Paired buy/sell deals are a type of indirect wheeling and will effectively allow Alberta utilities to gain access to U.S. markets through B.C. It is hoped that, through further negotiations, true wheeling arrangements can be reached to the benefit of all parties concerned. Moreover, within Alberta, the three major utilities form the Alberta Integrated System. This allows generation from one utility to be economically dispatched to serve not only that utility's native load but the integrated loads within the province.

Region 2

Utilities in Saskatchewan and Manitoba also prefer that wheeling be voluntary and that the prices charged for such services be market-based. It would thus appear, on the

Figure 4.1

Regional Cooperation and Development Opportunities


REGION 1
B. C.
ALTA.
1000
1200
CANADA
U. S. A.
2300
U.S. PACIFIC NORTHWEST
5200 (AC & DC)
CALIFORNIA
REGION 2
SASK.
MAN.
200
150
830
1450
CANADA
U. S. A.
U.S. MIDWEST (MAPP)
REGION 3
MAN.
ONT.
QUE.
375
210
200
1450
2500
2000
2200
1400
CANADA
U. S. A.
ECAR
NEW YORK
REGION 4
ONT.
QUE.
NFLD.
200
1450
5300
2200
1400
2000
CANADA
U. S. A.
NEW YORK
NEW ENGLAND
REGION 5
QUE.
N.B.
P.E.I
N.S.
930
730
140
40
400
2000
30
1000
CANADA
U. S. A.
NEW ENGLAND

surface, that the prospects of concluding wheeling arrangements which would allow Saskatchewan to gain access to the U.S. Midwest market via Manitoba and vice versa are reasonably good. It would, however, require these utilities to develop mutually-agreed wheeling arrangements which are not now in place.

Region 3

Within Region 3, the three utilities in Manitoba, Ontario and Québec appear to prefer that wheeling arrangements only be entered into voluntarily. The Ontario Ministry of Energy, in contrast, did acknowledge that some form of federal mandate may be required if agreement cannot be reached otherwise. However, because both Manitoba Hydro and Hydro-Québec are predominantly hydro systems and are physically far apart, the potential for interprovincial wheeling through the Ontario Hydro system appears negligible. As both Ontario Hydro and Hydro-Québec have substantial direct ties to New York wheeling of each other's electricity to serve that market is not an issue. There may, however, be opportunities for wheeling electricity to serve U.S. Midwest (ECAR) markets through Ontario.

If the benefits from such wheeling are substantial and solutions can be found to equitably distribute those benefits among the participants, it may be possible to conclude mutually satisfactory wheeling arrangements. It is noted, however, that the Canadian utilities in this region are among the country's major electricity exporters. They, therefore, have an intimate knowledge of the difficulties, complexities and opportunities involved in serving their respective major U.S. markets. Consequently, the potential for lost opportunities for Ontario Hydro to make direct sales as a result of wheeling, is an issue that would likely need to be resolved before such wheeling arrangements became a reality. In respect of U.S. utilities in ECAR, it is understood that when Ontario Hydro was making significant imports in 1990, the electricity involved in those imports was generated by utilities in Ohio, and transported to Ontario by means of simultaneous buy/sell arrangements with other utilities in Ohio and Michigan. Such arrangements can substitute for true wheeling.

Region 4

Within Region 4, Hydro-Québec favours a voluntary only approach to negotiating wheeling arrangements as well as the concept that the price for wheeling services should be based on market-related factors. Newfoundland and Labrador Hydro, on the other hand, prefers a voluntary approach, coupled with arbitration and federally-mandated solutions if voluntary agreements cannot be achieved. Moreover, it appears to prefer that wheeling be priced on cost-based rather than market-based factors.

For Newfoundland and Labrador Hydro to gain access to markets in Ontario and the Maritimes, and/or the international markets in New York and New England, would require the wheeling of electricity through Québec. Hydro-Québec, on the other hand, is strategically located geographically and has no need for wheeling services as it has direct ties to all these markets. The prospect, therefore, of successfully concluding mutually-satisfactory wheeling arrangements under the present circumstances appears to be low.

Region 5

There is disagreement among the three Maritime utilities concerning the process to be followed to secure transmission access and wheeling arrangements. NB Power favours the voluntary negotiations only approach while Nova Scotia Power believes that binding arbitration would be necessary for those cases where voluntary arrangements could not be reached. The provincial government in Prince Edward Island and Maritime Electric go one step further and suggest that a federal mandate may be required to force a solution in some cases. There is, however, no disagreement that pricing of wheeling services should be based on mutually-acceptable, market-related factors. It is understood that the Maritime utilities are trying to negotiate an arrangement which would allow Nova Scotia Power to supply Maritime Electric via New Brunswick. In addition, for certain types of transactions, NB Power has made arrangements with Hydro-Québec which would effectively allow that utility to have access to the New England market through New Brunswick using buy/sell arrangements. Recognizing that true wheeling among utilities in this region may be difficult to achieve under the present circumstances, it is gratifying to see that efforts are being made to expand multi-party interprovincial and international trade.

4.8 Options Available to Secure Transmission Access and Wheeling

The general wheeling principles and concepts outlined in this report, together with the reactions by the provinces and utilities to the proposed transmission policy, suggest that wheeling arrangements must be considered within the broader framework of inter-utility cooperation. From this analysis there appears to be a number of feasible options available to encourage and secure greater interprovincial/international transmission access and wheeling among Canadian utilities. The following seven options have been ranked in order of complexity. They are by no means exhaustive but do provide a reasonable range of options for consideration.

Each of the seven options described here corresponds to one of the options presented in the companion report on Inter-utility Cooperation. The correspondence of the two sets of options is illustrated in Table 4.2.

4.8.1 OPTION A - Establish Individual Transmission Access and Wheeling Policies

Although this assessment concludes that there is little commercial wheeling currently taking place in Canada, one utility, B.C. Hydro, has developed a transmission access policy and is prepared to enter into wheeling arrangements with other interconnected parties. It is understood that other utilities, notably in Alberta, are also in the process of developing their own transmission access and wheeling policies. Therefore, there appears to be a sense that in the current changing environment, other utilities might also be prepared to address these matters. Under this option, individual utilities would develop their own policies to allow transmission access and wheeling by other utilities and non-utility generators. This option would require no new regulations by the federal government.

4.8.2 OPTION B - Individual Policies with Federal Monitoring

Under this option, utilities would establish their own policies, and the federal government would undertake to monitor progress on a regular basis. Agreements concluded through voluntary negotiations among utilities or between a utility and a non-utility generator could be filed with a federal agency for public information and could be used by other interested parties. Monitoring progress and dissemination of information might provide added impetus for participants to reach agreements through a better understanding of the issues involved and through a sharing of experience gained by parties who have engaged in wheeling and transmission access activities. As in Option A, this option would require no new regulations by the federal government.

Table 4.2

Correspondence of Options

Transmission Access	Inter-utility Cooperation
Option A	Option 1
Option B	Option 2
Option C	Option 3
Option D	Option 3
Option E	Option 3
Option F	Option 4
Option G	Option 4

4.8.3 OPTION C - Establish an Industry Standard Policy

To be successful, wheeling arrangements require multi-party agreements. This option proposes that within the regional planning entities, as described in the Board report on Inter-utility Cooperation, utilities should not only establish their own transmission access and wheeling policies but should cooperate with a view to establishing comprehensive policies generally acceptable to all utility members. Moreover, industry standards developed by the utilities should take into consideration transmission access and wheeling for non-utility generators, including independent power producers. These matters will have to be addressed as greater reliance is placed on such alternative supply sources to meet expected load requirements.

While the development of individual utility policies would provide transmission access and wheeling to others on terms developed by each utility, it would not, on its own, guarantee that mutually-agreeable commercial arrangements between participants could be struck. Establishment of a committee within the regional planning entity to oversee development of an industry standard would provide a forum for utilities to compare their individual policies with the aim of seeking commonality and eliminating differences.

As in Option B, individual utility policies and industry standards, as well as voluntary negotiated agreements, would be filed with a federal agency for public information and could be used by other interested parties. This option would not require development of new regulations by the federal government.

4.8.4 Option D - Voluntary Negotiations with Non-Binding Arbitration.

This option is an extension of Option C. In this case, the added dimension would be the establishment within each regional planning entity of a dispute resolution mechanism which would include non-binding arbitration. Any member could request a hearing before its peers. Under all circumstances other members, who are most knowledgeable of the technical, economic, and financial factors involved, would be in control of the dispute resolution process. Therefore, this option would not involve any intervention by the federal and provincial governments. It would rely, essentially, on the good offices of other utility members not involved in the dispute to hear the complaints, to suggest equitable and fair solutions and, as appropriate, to apply peer pressure to resolve these matters.

This option would rely principally on cooperation, good faith and appropriate peer pressure by unbiased parties to reach solutions. Although it would not provide guarantees that commercial arrangements would be achieved, it would, nevertheless, provide the framework to distinguish and expose real, honest differences as opposed to those resulting from arbitrary and capricious actions.

The arbitration mechanism described here would be set up within the regional planning entities with industry personnel not involved in the disputes acting as arbitrators. Another alternative would be to rely on a non-governmental body, unrelated to the regional entities or their members, to be the arbitrator.

4.8.5 Option E - Binding Arbitration

This option takes the dispute resolution mechanism a step further. If it was believed in advance that resolution of conflicts would not be possible under the process described in Option D, then members of the regional planning entities could elect binding arbitration as a means of forcing a solution. In all other respect the dispute resolution process would be identical to the previous option. The fundamental difference would be that, under this option, members would have to agree beforehand that they would accept the judgement of the arbitrators.

The advantage of this option over the previous one is the strong likelihood that members would come before the disputes panel only with their very best technical, economic and financial arguments to prove their case. Added to this is the near certainty that the panel, consisting of industry peers, would never render a solution which they themselves would not accept for their own organization.

On the other hand, with binding arbitration there would be potential to adversely affect cooperation in other areas. In a real sense, resort to binding arbitration would be a recognition of failure between the parties involved to reach equitable solutions through cooperation, good faith and mutual respect.

4.8.6 Option F - Political/Regulatory Process

If, after all avenues offered by the regional planning entities or any other non-governmental body had been exhausted, utilities and/or non-utility generators were still unable to conclude commercially-satisfactory wheeling arrangements, then it might be necessary to find redress outside of these organizations through a federal agency with authority to mandate a solution.

This option proposes that such a federal agency would only be allowed to exercise these powers when specifically directed to do so by the federal government on a case-specific basis. Such a process is not unlike the present authority of the Board in respect of construction and operation of interprovincial power lines under Section 58(4) of the NEB Act. In effect, the Governor in Council may now designate an interprovincial power line as a facility that is to be constructed and operated under and in accordance with the provisions of the NEB Act. Although Section 58(4) has never been applied, it does provide an avenue of last resort. This, in and of itself, could add impetus and incentive for utilities to voluntarily reach mutually-satisfactory arrangements rather than face the prospects of a federally-mandated solution. This option would require changes to the NEB Act and its regulations.

4.8.7 Option G - Regulatory Process

This option is similar to Option F with one significant difference. Utilities that could not reach acceptable transmission access and wheeling arrangements would be able to seek redress by making application directly to a federal agency such as the Board. As with Option F, this option would require changes to the NEB Act and its regulations.

4.9 Conclusions

It is clear from this review that transmission access and wheeling raise many complex issues of a technical, economic, financial and jurisdictional nature. There is no single solution that would enable all these matters to be addressed to the satisfaction of all parties concerned. Like inter-utility cooperation, transmission access and wheeling arrangements can best be established and developed by the utilities and other interested parties working together with the objective that all parties benefit. To the extent possible, wheeling arrangements should be arrived at voluntarily among the parties involved. Only as a last resort, when there is an impasse, should mandated wheeling be contemplated.